PRACTICAL AND APPLIED ANATOMY

H. A. REEVES.

HUMAN MORPHOLOGY

VOL. I.

HUMAN MORPHOLOGY

PRACTICAL AND APPLIED ANATOMY

BY

HENRY ALBERT REEVES, F.R.C.S. Ed.

Formerly Demonstrator of Anatomy at the London and at the Middlesex Hospital Medical Colleges, and Lecturer on Anatomy at the London School of Medicine for Women; Surgeon and formerly Pathologist to the Hospital for Women; Surgeon to the Royal Orthopædic Hospital; Surgeon to the East London Children's Hospital; Assistant-Surgeon and Teacher of Practical Surgery at the London Hospital; Consulting Surgeon to the Westminster General Dispensary; formerly Assistant-Surgeon to the Central London Ophthalmic Hospital and Surgeon in co-charge of the Aural Department and Surgical Registrar at the London Hospital; &c.

Vol. I.—The Limbs and the Perinæum

With Five Hundred and Sixty-four Illustrations

LONDON

SMITH, ELDER, & CO., 15 WATERLOO PLACE

1882

This Volume is Dedicated

TO

MEDICAL STUDENTS GENERALLY

AND ESPECIALLY TO THE STUDENTS OF THE

LONDON AND THE MIDDLESEX HOSPITALS

WITH THE BEST WISHES

OF THEIR FORMER DEMONSTRATOR

THE AUTHOR

PREFACE.

When, some years ago, I was requested to undertake a work the first volume of which is now before the profession, I acceded, in the belief that a larger practical book on anatomy, which should be copiously illustrated and which should also include the important subject of Anatomical Technics, would be acceptable as a handbook to the student ambitious to obtain the higher degrees, and as a work of reference to the physician, practitioner, and operating surgeon. If any apology or further reason be required for producing another anatomical work, it must be found in the fact that there is no precisely similar work on practical anatomy in any language.

Almost the whole of the work has been written for some years, but several causes have interfered with its earlier publication, the chief of which have been the necessity for repeated condensation and the exigencies of private and increased hospital practice; but, notwithstanding that I have altered the original comprehensive character of the work, and have excised many interesting notes on what we at present call *anomalies*, and moreover (this being to me the most disagreeable part) have considerably reduced the sections on the practical applications of my subject, yet the complete work will extend to three volumes of between six and seven hundred pages each. I have also, in order to save space, deleted most of the paragraphs on unusual or *fancy* dissections, although these are undoubtedly serviceable to the student

preparing for the higher examinations; but the recent 'Manual of Dissections' by Dr. Carrington will, in great measure, make up for this enforced deficiency on my part.

My primary wish was to produce a treatise which should be serviceable alike to the student of human anatomy whose goal is private practice, and also to the student of comparative anatomy; and my scheme was to deal first thoroughly with the human subject, then to compare it with other vertebrates, giving directions as to the dissection of the chosen types. The sections on the arm and leg, according to this plan, had been prepared; but I soon found that to do the work in anything like a satisfactory manner, even from a student's point of view, would involve so much time, space, and expense for additional illustrations, that I had better relinquish my first idea and leave its execution to more competent hands. It is much to be desired that such a work as that just indicated should be undertaken by several co-workers, and be amply illustrated, although I confess there is much to be discovered before the work could be thorough.[1]

Anatomical nomenclature and classification generally, but especially the terms at present in use in myology, are very unsatisfactory, and I had attempted a revision in this department. However, I soon found that before this can be satisfactorily done the subject of comparative myology must be much more thoroughly worked out, a task requiring much time and many labourers. Dr. Gadow has recently added an able monograph to this interesting subject in Gegenbaur's 'Morphologisches Jahrbuch.' Those interested in the history of anatomical nomenclature and in the exposition of its absurdities, should consult Hyrtl's 'Onamatologia' recently published.

The reproach—formerly perhaps valid—that scientific anatomy was neglected in this country cannot now be upheld, seeing that our anatomical professoriate can boast of such justly honoured names as those of Owen, Huxley, Flower, Humphry, Parker,

[1] Professor Gegenbauer has, I have recently heard, been for some time engaged at a work on Human Anatomy on the lines I have just indicated. To me its publication will be most welcome.

Struthers, Turner, Cleland, Redfern, Houghton, Pettigrew, Buchanan, Mivart, and Lankester. Among younger men who are raising the teaching of human anatomy, the following names stand prominently out, Balfour and Creighton of Cambridge, Thane and Curnow of London, Macalister and Cunningham of Dublin, Jeffries Parker of Otago University, New Zealand, Charles of Cork, Watson of Owens College, Manchester, Mitchell Banks of Liverpool, Nunneley of Leeds, Clark of Glasgow. The various lecturers and demonstrators at the London and provincial schools are, nowadays, doing excellent service by paying more attention to the teaching of applied anatomy, and I hope the day is not far distant when students will be taught and examined in the bearings of anatomy to surgery, medicine, and gynœcology.

A few words as regards the illustrations. Ten years' experience in teaching anatomy has convinced me of the great utility of figures in lightening the labour of learning and teaching this science—it being, of course, understood that this book is to be chiefly used *while the student is dissecting.* The publishers have, in consequence, been liberal in the matter of illustrations, and as the work had to be produced at a price suitable to the majority of students, it must be obvious that if (as I should have liked) all the figures had been newly drawn and cut, this necessary condition could not have been fulfilled. Moreover, there is nothing gained by reproducing that which is already well represented. I therefore obtained as many illustrations as requisite from the best sources at my disposal, but a large number has been specially prepared for this work. Some of the latter are from my own drawings and dissections, and several have been executed either by or under the direction of Mr. E. N. Smith, others by Mr. D'Alton, and a few by my friend Mr. Kendle, of King's College. Some of the figures are, perhaps, somewhat rough and diagrammatic, but I strongly hold that illustrations, if deficient in an artistic sense, may nevertheless be very useful to the student, provided the anatomical details be correct.

The borrowed illustrations, most of which have been altered and improved in the lettering, are from the well-known works of

Sappey, Cruveilhier, J. A. Fort, Hirschfeld and Leveillé, Beaunis and Bouchard, B. Anger, Richet, Tillaux, Jamain, C. E. Hoffmann, Heitzmann, and Henle, and will be familiar to anatomists. A few are from English sources, and are acknowledged in the text. The reader will observe that the number of figures in this volume, which only deals with a part of my subject, nearly equals the whole number in similar works which embrace the entire subject, and include histology.

I have purposely omitted all illustrations and detailed description of minute anatomy, because there can be no question but that the proper way and place to learn histology is *practically*, in the microscopic laboratory; but where the subject seemed to demand it I have given as much information as may be verified by a good hand lens. I hope that the brief historical sketch, the glossarial index, which has been prepared by Dr. J. G. Garson, and the summary of dissections will be of some service to students, and that the bibliography and chapter on anatomical technics may be useful to lecturers, demonstrators, and curators.

The Appendix, which consists of illustrations of several sections of the limbs and of some of the more common arterial deviations, will, I trust, be found of use to the operating surgeon and advanced student.

I have much pleasure in expressing my great obligations to Dr. Garson, Anatomical Assistant at the Royal College of Surgeons, for the excellent account of the method of preparing frozen sections. I have added a few paragraphs to it which may prove of use.

The present volume is as much as the first year student can manage; the second volume, dealing with the thorax, abdomen, pelvis, and dissection of the back and spinal cord, will be ready next year; and the third, which will be occupied with the anatomy of the head and neck, brain, organs of special sense, and anatomy of the fœtus, will shortly follow it.

I echo and heartily emphasize Marjolin's advice to students: 'The study of anatomy presents numerous difficulties to those who engage in it with method, and still more, perhaps, to those

who adopt a bad one. . . . therefore, 1. Choose a good author. 2. Study methodically. 3. Dissect each part yourself.' Should I be the author chosen, I would advise the first year student to omit reading the paragraphs headed *Varieties*, but to go over them carefully when dissecting the parts for the second or third time. He will also impress the origin, course, and distribution of the blood-vessels and nerves on his memory by colouring them in different tints when he has read about them.

THE AUTHOR.

6 Grosvenor Street, London, W.
August, 1882.

CONTENTS.

CHAPTER V.

DISSECTION OF THE LOWER LIMB

CHAPTER VI.

HOMOLOGIES OF THE LIMBS

CHAPTER VII.

DISSECTION OF THE PERINÆUM

APPENDIX.

LIST OF ILLUSTRATIONS.

INTRODUCTION.

ANATOMICAL TECHNICS.

DISSECTION OF THE UPPER LIMB.

DISSECTION OF THE LOWER LIMB.

DISSECTION OF THE PERINÆUM.

SECTIONS THROUGH THE LIMBS.

HUMAN MORPHOLOGY.

CHAPTER I.

HISTORICAL SKETCH OF ANATOMY.

Some knowledge of the antecedents of the science one is about to study is of advantage to the student, and the following brief account is introduced as likely to prove useful and interesting.[1]

A vast deal of research has been employed in tracing the origin of anatomy to India and Egypt, chiefly because these countries were the cradles of civilisation. But in India the doctrine of metempsychosis precluded the dissection of animals. The process of embalming of bodies among the Egyptians chiefly consisted in the removal of the viscera and the introduction of resinous substances. The embalmers, moreover, were ignorant men of the lowest class, and so execrated by the people that Diodorus Siculus says, 'they had frequently to perform their function to the danger of their life.' The fragmentary knowledge thus obtained cannot be dignified by the name of Science.

The Greeks had similar prejudices as regards the dead, so that their physicians and philosophers were chiefly confined to the study of the bodies of the lower animals, in order to obtain an approximate knowledge of the structure of the human body. And thus from its very beginning was the progress of anatomy obstructed and interrupted, nor is anatomy even now completely emancipated.

The history of anatomy, excluding what may be called its mythological epoch, is generally divided into three periods: from Hippocrates to Galen; from Galen to Vesalius; from Vesalius to the present time.

FIRST PERIOD.

HIPPOCRATES, 466 B.C., TO GALEN, 130 A.D.

There can be no doubt that Hippocrates possessed good general notions of the skeleton and of the general structure of the human body, but the profound knowledge of anatomy, strictly so called, attributed to 'the

[1] Only the most important epochs and names have been given, as space will not admit of a fuller account, which, moreover, is not actually necessary to the student.

7b

father of medicine' by ancient and some comparatively modern authors, such as Riolan and Bartholinus, is evidently exaggerated. Of the many works ascribed to him only four or five are considered as genuine; the rest have been written by his disciples and successors.

It is not probable that Hippocrates ever dissected a human body, as some authors, even Haller, believed. Gruner in a very learned treatise 'An Hippocrates cadavera humana secuerit,' has apparently set this question at rest. Haller endeavours also to show that Hippocrates possessed a fair knowledge of neurology; but there can, strictly speaking, be no question of the neurology of Hippocrates, inasmuch as he does not distinguish between nerves, tendons, and ligaments. The brain he describes as a large gland secreting a viscid fluid, the lungs as spongy bodies which communicate with the heart, and their chief use is to cool the body by the inspired air. All the veins proceed from the heart; in the veins the blood is formed; the arteries contain the vital spirits: but he confounds both under the general name of veins, nor does he allude to their difference of structure.

The strength of the anatomy of Hippocrates lies in his osteology, for he has well described the relations of the bones to each other—their articulations and movements—and applies this knowledge to the diagnosis and treatment of fractures and dislocations. It is stated that he consecrated a skeleton of bronze to Apollo in the temple at Delphi, in order to teach to his disciples the importance of studying the human frame.

Among the most distinguished disciples of Hippocrates must be named Polybus, the son-in-law of the father of medicine; for it is to Polybus (about 370 B.C.) that the authorship of the books, 'On the Nature of Man' and 'On the Nature of the Child,' has been ascribed.

PLATO AND ARISTOTLE (384 *B.C.*).

Plato's notions of anatomy and physiology are scattered in his various works incidentally. It is especially in his 'Timaeus' that we meet with them, but they will scarcely bear extraction.

Aristotle, born 384 B.C., at Stagyra, was descended from a family which traced its origin to Æsculapius. Nicomachus, the father of Aristotle, was a physician, who is said to have left some works on Natural History and Medicine. Aristotle was about forty years of age when he undertook the education of Alexander the Great. The expeditions of his pupil in Asia furnished him with the most ample materials for the extension of his knowledge of the structure of all sorts of animals. His zootomical knowledge became thus not only extensive, but more accurate than before, and he may therefore justly be considered as the founder of comparative anatomy, which necessarily preceded human anatomy. Although Aristotle refers everything to man, it yet nowhere appears in his writings that he had ever dissected a human body. His descriptions are sufficiently accurate when applied to the external parts of the human body, but when he describes the internal parts they become erroneous. In fact, he says himself ('Hist. Anim.' lib. i. c. 16[1]), the internal parts are unknown, that

[1] 'De interioribus vero contrarium obtinet. Ignotæ enim sunt imprimis humanæ, quamobrem ad reliquorum partes animantium relatas, quibuscum habent naturæ similitudinem, eas contemplari debemus.'

there was nothing certain upon the subject, and that we must judge by the resemblance which they ought to have to those of other animals. It thus appears clear that the anatomy of Aristotle was not founded upon the dissection of the human body.

The Aristotelian anatomy is in fact contained in his 'History of Animals.' Correcting the statements of some of his predecessors, who taught that the blood-vessels arose from the brain, he traced them to two large vessels placed on the right and left before the spinal column, one of which, he remarks, is sometimes called the *aorta.* He describes both these vessels to arise from the heart. But while his description of the distribution of the aorta is sufficiently correct, he is at fault as regards the vena cava and the pulmonary artery, which he confounds. He distinguishes the trachea from the œsophagus. He had some, though not very clear, notions of the larynx and epiglottis, and was well acquainted with the alimentary canal of animals. While, therefore, Aristotle has rendered great services to comparative anatomy, he has not contributed much to human anatomy.

THE SCHOOL OF ALEXANDRIA (320 *B.C.*).

About the beginning of the third century before Christ, Ptolemæus the First founded a school at Alexandria, which in a comparatively short time became a scientific centre for the most distinguished men of that period. The cultivation of human anatomy then became a reality, for, as Pliny informs us, the Egyptian rulers not merely furnished the anatomists with human bodies, but that they themselves dissected, in order to show the people that there was nothing dishonourable in doing so. As the first anatomist of this school must be mentioned Herophilus, who lived under Ptolomæus Soter (about 344 B.C.).

There can be no doubt that he dissected human bodies, and became thus to a certain extent the founder of human anatomy. If we are to believe Celsus, he even dissected animals alive; hence Tertullian called him *lanius* (executioner). The works of Herophilus are lost, and all that we know of his anatomical researches must be gleaned from the notices of Galen, Oribasius and others. Herophilus describes the pulmonary artery, which, however, he calls the **venous artery**, and he, as well as his rival Erasistratus, seems to have known the chyle vessels of the alimentary canal, as acknowledged even by that modern discoverer Caspar Aselli. He gave the name of 'twelve-inch gut-duodenum' to that portion of the alimentary canal next to the stomach. He studied attentively the encephalon, some parts of which, such as the straight venous sinus, still bear his name (*Torcular Herophili*). The *calamus scriptorius*, at the bottom of the fourth ventricle, is also said to be indebted to him for its name.

ERASISTRATUS.

After Herophilus must be mentioned his distinguished contemporary, Erasistratus, born, according to Strabo, in the isle of Ceos or Cea, and not at Cos, as some have asserted. He was of the family of Aristotle. Galen

tells us that Erasistratus only devoted himself earnestly to the study of anatomy after he had given up practice as a physician. Hence, he had to retract many of his opinions. Thus, having taught that the nerves proceeded from the dura mater and not from the brain, he now acknowledged his error. Erasistratus knew of the valves of the heart, and distinguished them as the *sigmoid* and *tricuspid*; he also paid special attention to the anatomy of the brain: he described its convolutions, ventricular cavities, the origin of the nerves, and their distribution. He even distinguishes two species of nerves—those of sensation and those of motion. He shared with Herophilus the credit of having observed the chyliferous vessels in goats killed after feeding; but their discovery remained sterile until they were rediscovered by Aselli.

After Herophilus and Erasistratus the progress of anatomy seems to have received a check. Human bodies were no longer dissected, and the instruction in the schools seems to have been confined to the anatomy of animals. From this period also dates the dispute between the empirics and the dogmatics, the former rejecting anatomy as a useless science, while the latter justly maintained that, in order successfully to battle with disease, the physician should be acquainted with the structure of the body and the functions of its parts. Enough, anatomy fell into undeserved neglect, so that, among the numerous successors of Herophilus and Erasistratus to the time of Galen, there are only three names which deserve mention in relation to anatomy; namely, *Marinus*, who lived under Nero, and whom Galen describes as the restorer of anatomy. None of his writings have reached us, but Galen seems to have liberally availed himself of his labours. He is mentioned as having fixed upon seven as the number of pairs of nerves, and also to have described the hypoglossal under the name of the sixth pair.

After Marinus appeared *Rufus Ephesus*, who, according to Suidas, lived in the reign of Trojan. The works of this author which have reached us are, 'De Vesicæ Renumque Morbis;' 'De Purgantibus;' 'De Partibus Corporis Humani.' He tried to fix the anatomical nomenclature. He admits that his description of the human body was founded upon his studies of the bodies of apes. He distinguished the nerves into two classes, those of sensation and of motion; he recognised the Fallopian tubes, and was probably the first who described the chiasma of the optic nerves.

Aulus Cornelius Celsus probably lived in the Augustan age (about 40 B.C.–20 A.D.), but neither this point, nor even his profession, is perfectly ascertained, for he wrote treatises on agriculture, rhetoric, and military matters, as well as on medicine. What concerns us here is that his work 'De Medicina,' consists of eight books, which have reached us as a rich depository of the anatomical knowledge possessed at his period. From this work it appears that Celsus was well acquainted with the central organs of respiration and circulation, the trachea, lungs, and heart, and also with the alimentary canal and abdominal glands. He had a fair knowledge of the uterus and its appendages. His knowledge of osteology seems to have been extensive. He describes the sutures, and some of the apertures of the cranium, the maxillary bones, the vertebræ and their articular connections. It is even supposed by some that he knew the semicircular canals.

The *Editio princeps* of Celsus is that of A. Nicolas, Florent., 1478. Numerous other editions and translations have since appeared.

Here may perhaps be mentioned Pelops, the teacher of Galen, who made myology his special study, as may be inferred from the book of Galen, 'De Muscul. Dissectione.'

SECOND PERIOD.

GALEN TO VESALIUS.

Claudius Galenus was born, about 130 A.D., at Pergamos. After receiving his elementary instruction from his father, Nicon, a philosopher and mathematician, he commenced his anatomical and medical studies under Satyrus, a celebrated anatomist, and subsequently went to Smyrna, where he received the instructions of Pelops, mentioned above. After the death of his father, Galen travelled to Alexandria, when having possessed himself of all the medical knowledge there obtainable, he returned to his native place, and, finally, when thirty-four years of age, settled at Rome, where he soon obtained the most extensive practice. Few physicians of his time have worked as hard as Galen. He is said to have written more than five hundred treatises, of which a considerable portion were destroyed by a fire. Of those which Galen himself states as having been burnt we shall only cite 'Libri iii. de Anatomia Erasistrati;' 'Libri de Sectione Mortuorum;' 'Libri ii. de Sectione Vivorum,' &c. &c.

Owing to their loss, we possess a comparatively scanty amount of the state of anatomy during the most flourishing period of the Alexandrian school. But enough has remained of the works of this voluminous writer to form a pretty accurate idea of the state of anatomy at his time, and of the merits of Galen as an anatomist.

It does not appear that Galen had at any time many opportunities of dissecting human subjects. His dissections were chiefly confined to the lower animals and to apes, to which circumstance must be ascribed most of the errors in his anatomical descriptions. Still, it is wonderful with what sagacity he, from the dissection of animals, analogically inferred the structure of the human body. The osteological descriptions of Galen are, considering all circumstances, clear and accurate enough. He distinguishes the bones and sutures of the cranium; he describes the parietal, sphenoid, temporal, and ethmoid bones, and he divides the vertebræ into cervical, dorsal and lumbar.

The myology of Galen, although perhaps less complete than his osteology, is nevertheless singularly rich and accurate. He describes the principal muscles of the head, of the trunk, and extremities. The six muscles of the eye, the recti and the obliqui, the muscles of the tongue, the larynx, the chest, the abdomen, &c., are not only well described, but their actions explained; so that most of the names by which the respective muscles are distinguished are still retained in modern anatomy.

In neurology Galen distinguishes the cerebral from the spinal nerves. He admits only seven pairs of cerebral nerves, and traces their distribution. Although his description of the brain is not of man but of an ox, yet it is

remarkably complete. He describes the ventricles, the corpus callosum, the fornix, the pineal and pituitary glands, the corpora striata, the optic thalami, the tubercula quadrigemina, the pes hippocampi, the aqueduct (now called the aqueduct of Sylvius), the choroid plexus, and the medulla oblongata.

The angiology of Galen is, owing to his physiological ideas, necessarily defective. Following Erasistratus, Galen distinguishes the veins from the arteries; but, in opposition to his predecessors, he maintains that the arteries contain, in the living animal, blood and not air. He represents all the arteries to arise from the left ventricle of the heart by two trunks—the one is distributed to the lungs (pulmonary veins); the other divides into an ascending and descending branch. The veins originate, according to Galen, in the liver; he recognises two main trunks, the vena portæ, and the vena cava. The ascending portion of the vena cava sends a voluminous branch to the right ventricle, which then is distributed to the lungs (pulmonary arteries).

The intimate knowledge which Galen possessed of the structure of the heart and its valves, of the semilunar or sigmoid valves of the aorta, and of the pulmonary artery and their action, shows how very near Galen approached the solution of the question of the circulation of the blood. Some authors, indeed—Hecker, for instance [1]—assert that the honour of having first discovered the circulation of the blood belongs to Galen, but that his remarks on this subject are so scattered, that he did not perceive its physiological importance and practical application; hence it was soon forgotten.

This short and necessarily incomplete sketch of the merits of Galen sufficiently shows how much anatomy is indebted to him. Of Galen as a physiologist and a physician it is not our object to treat here.

The unbounded influence which the authority of Galen exercised during many centuries over the minds of his medical successors can only be compared to that of Aristotle over the scholastic world. In one respect the deference paid to his authority contributed rather to retard the progress of medical science, by discouraging independent research; for it was little short of heresy to doubt the dicta of the master.

After the death of Galen, we find but few names deserving mention in the history of anatomy. To Soranus of Ephesus, who lived under Trajan, is attributed a treatise on the female organs of generation, which testifies to the considerable anatomical knowledge of the author. Oribasius of Pergamos, said to have been the physician of Julian the Apostate, was more of a compiler than an anatomist; while Aëtius and Paulus Ægineta were rather celebrated as surgeons and physicians than as anatomists. The period was now fast approaching when the cultivation of science and art was rendered almost impossible. Hordes of barbarians from the North overran the Roman Empire, extinguishing the torch of civilisation and introducing their barbarian laws. Thus, during the whole of the period called 'the dark ages,' science found no resting place in Europe, except in the countries conquered by the Arabs.

[1] *Die Lehre vom Kreislauf von Harvey*, Berlin, 1831. The chief passages relative to the circulation are to be found in the treatise *De Usu Partium*, lib. iv. vi. vii. &c.

ANATOMY OF THE ARABS.

After the conquest of Egypt by Omar (640), the Arabs began to appreciate scientific culture. The Greek Christians in Syria, and also the Jews, became the teachers of the conquerors by new translations of Greek works into Arabic. An academy was instituted at Bagdad, and a college of physicians, the president of which had to examine all such as intended to practise the art of healing.[1]

Almamum, the grandson of Almansur, became the great promoter of the culture of science, for he gave orders to his ambassadors in Greece to purchase all Greek and Roman works they could obtain in order to have them translated. Under the Moorish khalifs Spain became the chief seat of learning. Alhakem erected an academy at Cordova which during several centuries was the most celebrated in the world, and was frequented by all desirous of obtaining knowledge. The library contained, according to Casiri, 250,000 books. Sevilla, Toledo, and Murcia also had high schools, which flourished until the end of the Moorish dominion.

The anatomy of the Arabian physicians was almost entirely borrowed from the Greeks, chiefly from Galen, as the Koran forbids dissection. Yet there were not wanting physicians among the Arabs who declared that anatomy could not be learned entirely from books, and that even Galen's dicta must be verified by autopsy.

Under these circumstances it was nigh impossible that anatomy, as such, could flourish. The most celebrated names amongst the Arab physicians, such as Ibn Sina (Avicennes), *Rhases*, *Averrhoes*, &c., were almost all blind followers of Galen, and left no mark in anatomical science.

In the beginning of the thirteenth century (1213), Frederick II., King of the Romans and Sicily, promulgated a law, according to which no one was allowed to practise surgery unless he had previously undergone an examination in anatomy. A certain Martianus, a physician of Sicily, is said to have received from this prince authority to give every five years lectures on the dead body to physicians and surgeons. The revival of science in general, and with it of anatomy, took place in Italy. Bologna first, and afterwards Pisa and Padua, acquired great celebrity as medical and anatomical schools, and attracted students from all parts of the world.

The revival of practical anatomy may be said to have commenced with Luigi Mendini de Luzzi (Mundinus or Mundinius). He was probably born at Bologna, where, it is said, his father kept an apothecary or druggist's shop.

In the year 1314 Mundinus was professor at Bologna, and in 1315 he publicly dissected two female subjects. Not long after, he published a treatise on anatomy, which for a long time was the only text-book used in the Universities of Bologna and Padua. The first edition bears the title 'Anothomia' (*sic*) Mundini, &c., Papaia, 1478. Another edition, illustrated by woodcuts, entitled 'Fasciculus Medicinae,' &c., was published by J. Kethem, Venetiis, 1495. One of the woodcuts represents Mundinus lecturing, surrounded by students; a dead body lying on the table to be dissected.

[1] Abulfarag, *Chron. Syr.* p. 181.

As to the work itself, every page shows that Mundinus is a follower of Galen. Still his descriptions of some parts are much more complete than those of Galen. Thus Mundinus distinguishes the alimentary canal into duodenum jejunum, ileum, colon and rectum, commencing by the rectum. On the other hand, the Latin is corrupted by the introduction of the nomenclature of Arabian authors, so that he calls the abdomen *mygrach*, the peritoneum *syphac*, and the omentum *zirbus*. Amidst much that is fanciful, he nevertheless states facts founded on experiments. Thus he says, when the recurrent nerves are divided, the animal loses the voice. His anatomy of the heart is singularly correct, as well as the description of the pulmonary arteries and veins, so much so that he has also been claimed as one of the discoverers of the circulation of the blood. With much greater reason may Mundinus be designated as the precursor of Gall with regard to the localisation of the functions of the brain, which he divides into different compartments, or cells, each containing an intellectual faculty. Mundinus died about 1325.

In connection with Mundinus must be mentioned his pupil and commentator, Alexand. Achellini, who is known as having first described two of the tympanal bones, the *malleus* and the *incus*. He, moreover, corrected some of the errors of his predecessors as regards the disposition of some of the intestines.

Mathiew de Gradibus, or Gradi, so called from his birthplace, Grado, near Milan, was professor at Pavia, where he died in 1480. Gradi is chiefly known by having given a better description of the ovaries than any of his predecessors.

Gabriel Zerbi, or De Zerbis, professor at Bologna, Rome, and Padua, had the reputation of being one of the most learned physicians of his time. He and his son were murdered in Turkey in 1505. He published his 'Anatomicæ Corporis Humani,' &c., Venetiis, 1502, fol.

Hundt (1449–1519, Magnus Canis), born at Magdeburg, rector of the University of Leipzig, is chiefly known by his 'Anthropologium de Hominis Natura,' &c., published at Leipzig in 1501. This work is one, if not the first, of the anatomical works illustrated by woodcuts.

Very eminent in the history of anatomy is the name of Berengario de Carpi, professor at Pavia and Bologna between 1502 to 1527. His first demonstrations were on animals, but subsequently he dissected, according to his own declaration, above one hundred human bodies. Many discoveries made by his predecessors are erroneously attributed to him; but it is undeniable that he first described the vermiform process of the caecum. His account of the brain, its ventricles, and the cerebral nerves, is excellent for his time, rectifying the mistakes of Galen, Mundinus, and others. He published a compendium of treatises under the name 'Isagogæ Breves in Anatomiam Corporis Humani,' Bononiæ, 1522. In this work Berengarius gives a systematic survey of the various textures in the human body. It may be mentioned, by the way, that Berengarius was one of the first who employed mercury for the cure of syphilis.

THIRD PERIOD.

FROM VESALIUS TO THE PRESENT TIME.—THE REFORMATION OF ANATOMY.

A man now appeared on the anatomical stage whose works marked the beginning of a new era in the history of this science. Andreas Vesalius was born at Brussels in 1514. The name of his family was originally Witting, who, emigrating to the Netherlands, changed their name to Wesele, from Wesel in the duchy of Cleve, their native town. Vesalius first frequented the University of Louvain, where he studied under Winter of Andernach, then went to Montpellier, and thence to Paris, where he had for instructors his old teacher Winter, and Sylvius and Vidius. From 1536–1543 we find him lecturing on anatomy in Padua, Bologna, and Pisa. During this period he prepared his grand work, 'De Corporis Humani Fabrica Libri Septem,' which he published at Basle in 1543, and which Boerhave called *opus incomparabile*, and Haller *immortale opus*. The splendid anatomical illustrations of this work, drawn by eminent artists, chiefly by Johann von Kalker, a pupil of Titian, if not by Titian himself, have been copied in almost all the anatomical works of the sixteenth century. Vesalius was not merely the first author of a comprehensive and systematic work on anatomy, but the foremost anatomist of his time who tried to shake off the yoke of Galen; and he thus became, if not the founder, at all events the great reformer of anatomy. He proved to demonstration that the anatomy of Galen was not the anatomy of *man*, but that of the apes and of the lower animals. The boldness with which he attacked the long-reverenced opinions of Galen and other ancient authors, and the irrefutable evidence with which he supported his own descriptions, raised him a host of enemies among his contemporaries. Among his bitterest opponents was his teacher Sylvius, who wrote a pamphlet against him, 'Sylvius VESANI Calumnias depulsandus.' Even his great colleagues, Eustachius and Fallopius, opposed him, though with much less virulence. About 1544 the Emperor Charles V. appointed him his physician; and on his abdication he became physician in ordinary to Philip II. of Spain. The constant attacks on Vesalius induced Charles V. to ask the theological faculty of Salamanca whether it be lawful for Catholics to dissect the human body after death. For a wonder the faculty replied in the affirmative. Still, the opposition he met with so embittered his life that he burnt a considerable portion of his manuscripts. About the latter end of 1563, Vesalius left Madrid and went on a pilgrimage to Jerusalem. The story commonly received, but by no means authenticated, is that, on removing the heart from the body of a Spanish grandee, it quivered in his hand, and that he was permitted to expiate his error by a pilgrimage to the Holy Land. Be this as it may, its end was melancholy in the extreme. On his return voyage to Padua, where he was to take the vacant professorship of anatomy on the death of Fallopius, his vessel was wrecked on the isle of Zante, where Vesalius died, according to some accounts, of starvation, but more probably from fatigue and exposure. A benevolent goldsmith

recognised his body and had him decently buried in a chapel of Our Lady, where his gravestone bears the inscription:

Andreæ Vesalii Bruxellensis Tumulus Eustachii.

Bartolomeo Eustachio or *Eustachius*, the contemporary of Vesalius, born in the early part of the sixteenth century at San Severino, was another of the distinguished Italian anatomists to whom the advancement of anatomy is due.

Eustachius held the chair of medicine in the Collegio della Sapienza; but as he never had any lucrative practice, he died in great poverty about 1574. His treatises are nearly all collected in his 'Opuscula Anatomica,' published in 4to at Venice, 1564, and again by Boerhaave, Leyden, 1707, in 8vo. His principal work 'On the Disputed Points of Anatomy,' announced in the 'Opuscula,' was, probably from want of means, not published, and lost. Nevertheless, thirty-nine copper-plates, intended for the illustration of that work, were found in 1712 at Urbino, and published in 1714 by Lancisi, with the aid of other anatomists. Several editions of them have since appeared. The plates abundantly show that many important anatomical facts which gave lustre to his successors must have been known to him. The tube leading from the tympanum to the throat and the valve of the vena cava bear his name.

Realdus Columbus of Cremona, Professor of Anatomy at Padua, born in 1544, was a pupil of Vesalius, and a skilful anatomist. In his principal work, 'De Re Anatomica,' l. xv. Venet. 1559 fol., he rectifies the anatomy of the bones, and gives a good description of the brain, the internal ear, and the ventricles of the larynx.

Jean Philip Ingrassias, another pupil of Vesalius, born in 1510 at Ragalbuto in Sicily, studied at Padua. In his commentary on the osteology of Galen, published in 1603, by his grandson, he corrected many errors and gave a correct account of the conformation of the ethmoid and sphenoid bones, hence the name *parvæ alæ Ingrassiæ*. He also first described the third bone of the tympanum, called *stapes*, a description equally claimed by Eustachius and Fallopius.

Gabriello Fallopio (*Fallopius*) was born at Modena about 1523; died at Padua in 1562. Fallopius was both the pupil and the successor of Vesalius at Padua. Although he at first took the part of Galen against his master, he tried to reconcile their teachings. His chief work (*eximium opus*, Haller), 'Observationes Anatomicæ,' which was published at Venice in 1561, just a year before his death, formed an epoch in the science of human anatomy. He rectified the description of many parts which Vesalius had left incomplete. He gave a more accurate account of the auditory apparatus than had hitherto been published, by describing the vestibule, the semicircular canals, the fenestræ, the aqueduct which bears his name, &c. In his researches on the organs of generation in both sexes, he discovered, or at all events first described, the utero-peritoneal canals (tubæ Fallopiae).

Julius Cæsar Aranzi (Arantius), born at Bologna about the year 1530 (died 1589), was also among the most eminent of the pupils of Vesalius. His work 'De Humano Fœtu Opusculum,' Venet. 1571, gives the first correct account of the anatomy of the fœtus. In his description of the anatomy of the brain, Aranzi was the first properly to describe the inferior

cornua of the ventricles; he also first described the hippocampus, the choroid plexus, and most of the sinuses at the base of the cranium, also the corpora Arantii of the sigmoid valves.

Constantia Varoli (Varolius), born at Bologna in 1543 (died in 1575), only published during his life a single epistle, 'De Nervis Opticis,' &c., Padua, 1572, in which he proposes a new method of dissecting the brain. He distinguishes, better than had been done before, the organs at the base of the encephalon, and especially the annular protuberance which bears his name (Pons Varolii). A long time after his death was published his principal work, 'De Resolutione Corporis Humani Libri Quatuor,' Francf. 1591.

Hieronimo Fabrizio (Fabricius ab Aquapendente) was born in 1537 at Aquapendente in the Papal States, and died, at the age of eighty-two, in 1619. He became at an early age the pupil of Fallopius, whom he succeeded in 1562. Fabricius is now chiefly remembered as having been the tutor of William Harvey, whose great discovery was, according to his own statement, suggested by the discovery of Fabricius of the valvular structure of the veins. Some of these folds or valves of the veins had been noticed by the predecessors of Fabricius, but no one had given a rational suggestion of their use until Fabricius traced them through the whole venous system ('De Venarum Ostiolæ,' Padua, 1603, fol.).

William Harvey, born at Folkestone, April 1, 1578; died June 3, 1657. After a residence of six years in Cambridge, he proceeded to Padua, where he attended the lectures of Fabricius on anatomy, and of Casserius on surgery. After taking his degree he returned home, and was appointed physician to St. Bartholomew's Hospital. The great discovery of the circulation of the blood, obscurely conjectured and partially taught by Servetus, was finally established by the labours of Harvey, who proved to demonstration, not merely the minor circulation through the lungs, but the general or systemic circulation of the blood from the left side of the heart, by the aorta and its subdivisions, to the right side by the veins. Although Harvey announced his views on the circulation as early as 1619, in his lectures, it was only in 1628 that he printed his 'Exercitatio Anatomica de Motu Cordis et Sanguinis in Animalibus.'

It is not within our scope to notice the controversies to which Harvey's discovery gave rise. The only opponent he condescended to answer was Joannes Riolanus, the son, Regius Professor of Anatomy at Paris.

Among the many claimants as regards priority in the discovery of the circulation, we may mention, merely as a curiosity, Leonardo da Vinci, whom Dr. Robert Knox, the well-known anatomist, with some hesitation mentions to that effect, not indeed as a discoverer, but as one to whom it might have been known. Dr. Knox, it appears, had an opportunity of examining in Queen Victoria's library a sketch-book of Leonardo. 'It is,' says Dr. Knox ('Great Artists and Great Anatomists,' London, 1852, p. 160), 'a small folio, prepared as a sketch-book, its leaves filled with figures drawn by Leonardo, chiefly from dissections made either by himself or conjointly with Della Torre. . . . Turning the leaves hastily over, I stumbled on a drawing of the semilunar valves of the aorta, in a variety of positions, so as to show their descriptive anatomy. The corpuscules of Arantius have not been forgotten. Now all this occurred long before the age of Fabricius and Harvey, and even before that of Vesalius; for Della Torre and Da Vinci preceded all these.

'It may have been that he was acquainted with the circulation of the blood. Who can tell the extent of his knowledge until the volume be carefully examined, figure by figure, line by line, page by page, by an anatomist?'

ANATOMY IN FRANCE AND ENGLAND.

Hitherto Italy had taken the lead in science, and consequently in anatomy; but the institution of the Collège de France, in 1550, by Francis I. attracted a great many students to that country. Among the professors appointed were Guidi Guido, better known by his Latin name Vidus Vidius, and Winter (Guinterius) of Andernach, a German. Vidius died in 1567. The anatomy of Guidi ('De Anatomia,' lib. 8) was published at Venice, in 1611. Winter published in 1536, for the benefit of his pupils, an elementary treatise on Anatomy, entitled 'Anatomicorum Institutionum secundum Galeni Sententiam ad Candidatus Medicinæ,' lib. iv., Basileæ. In this school were educated Charles Etienne, Servet, Jacques Dubois, (Sylvius), who himself became the teacher of Vesalius. Winter died in 1574, aged eighty-four.

Jacques Dubois (*Sylvius*) was born at Louvilly in 1478, and took his degree as Bachelor of Medicine in 1531; he was, at the departure of Vidius for Italy, appointed Professor at the College of Triquet.

There is no doubt that Dubois dissected many human bodies, yet such was his infatuation for Galen that he distrusted his own senses; hence his anatomy and physiology are almost entirely cast in the mould of the physician of Pergamos. Among his works are: 'Methodus sex Librorum Galeni de Differentiis et Causis Morborum,' Parisiis, 1539; 'Vesali cujusdam Calumniarum in Hippocratis Galenique rem Anatomicam Depulsio,' Parisiis, 1551. Dubois must not be confounded with Franciscus de le Boë, also called Sylvius. Dubois' name is perpetuated in anatomical nomenclature by the 'Fossa Sylvii,' and aqueductus Sylvii.

Among the distinguished pupils of Sylvius must be mentioned Charles Etienne, born at Paris about the beginning of the sixteenth century; died 1564, aged sixty. Of his anatomical works may be cited, 'De Dissectione Partium Corporis Humani,' Parisiis, 1545.

Servetus (Michal Servet), born in 1509 at Villa Nuova Arragonia, was also a pupil of Sylvius. In his work 'Christianissimi Restitutio' occurs a passage, which, if it does not by any means prove that he understood the systemic circulation of the blood, at all events shows that he had a fair knowledge of the pulmonary circulation. His fate is well known: he was burnt as a heretic at Geneva, in 1553, aged forty-four.

Andreas Cæsalpinus of Arezzo (1519–1619), the eminent philosophical botanist and physiologist, occupies perhaps the most prominent place among the predecessors of Harvey. He describes very clearly the pulmonary circulation, as is shown from the following passages:—'. . . to this circulation of the blood out of the right ventricle of the heart through the lungs into its left ventricle, what appears upon dissection answers very well.'[1] That he had a glimpse of the systemic circulation is proved by

[1] 'Huic sanguinis circulationi ex dextro cordis ventriculo per pulmones in sinistrum ejusdem ventriculum optime respondent ea quæ ex dissectione apparent.'—*Quæst. Peripatetic.* lib. v. cap. iv.

the following passage: 'In animals we see that the veins carry the aliment to the heart, as the workshop of the implanted heat, and after the aliment has acquired its highest perfection, the arteries distribute it through the whole body by means of the spirit which has been produced in the heart from the same aliment.[1]

Gaspar Asellio (Asellius), Professor of Anatomy at Pavia, born about 1581 at Cremona (died 1626), rediscovered the chyliferous vessels in a dog, in the year 1622. In 1628 they were seen by Nicolas Pairese in the autopsy of a convict who had been well fed before his execution. Jean Pecquet, a student at Montpellier, discovered in 1647 the common trunk of the lacteals and lymphatics in some domestic animals. Jahn van Hoorne, born at Amsterdam in 1621 (died in 1670), described the thoracic duct in the human body, 'Novus ductus chyliferus,' &c., Lugd. Batav. 1652. Thomas Bartholinus, born at Copenhagen in 1616 (died 1702), perhaps the most learned physician of his age; Olaus Rudbeck, professor at Upsala, born in 1630 (died 1702); George Jolyffe, and many others, were all occupied in tracing the distinction between the lacteals and the lymphatics. There is no doubt that Rudbeck traced the lymphatics of the large intestines to the thoracic duct, and this latter to the subclavian vein. This he demonstrated in the presence of Queen Christina in 1652.

The quarrels of the respective authors touching the priority of discoveries in the anatomy of the lymphatic system cannot be easily decided, owing to the almost simultaneous publication of their works on this subject. Aselli (in 1622), Pecquet (in 1649), and Rudbeck (in 1651) published their researches, but Rudbeck *generalised* their existence. Many anatomists have studied the lymphatic system: Bartholin, G. Jolyffe, Glisson, Fohmann, Hunter, Newson, Magendie, Mascagni, Meckel, Nuck, Ruysch, among the older ones; and Sappey, His, Recklinghausen, Waldeyer, Schweigger-Seidel, Toldt, Frey, Axel Key and Retzius and Klein, among modern ones.

Thomas Wharton, born 1610 (died 1673), investigated carefully the structure of the glands ('Adenographia,' &c., London, 1656), and gave his name to the *ductus salivalis inferior* (Wharton's duct).

Francis Glisson, born in 1597 at Rampisham, Dorset, made himself known by a most minute description of the liver ('Anatomia Hepatis,' &c., London, 1654). But the chief anatomical work of this period was unquestionably the 'Cerebri Anatome,' &c. by *Thomas Willis*, London, 1664. This work on the brain and the nervous system abounds in new information. The description is minute and generally accurate, so that the order in which he numbered the cranial nerves is still followed by modern anatomists. Willis acknowledges his great obligations to his intimate friend Richard Lower.

Nicolas Steno, born at Copenhagen 1638 (died 1686), accurately describes ('Observationes Anatomicae,' &c., Leyden, 1662) the lacrymal gland and passages, and the parotid duct, which bears his name.

[1] 'In animalibus videmus alimentum per venas duci ad cor, tanquam ad officinam caloris insiti, et adepta inibi ultima perfectione, per arterias in universum corpus distribui, agente spiritu, qui ex eodem alimento in corde gignitur' (*De Plantis*, lib. i. c. 2). In another passage (*Quæst. Med.* ii. 17), he points out the swelling of the veins beneath a ligature as a proof of the return of the blood by the veins.

MICROSCOPIC ANATOMY.

Marcellus Malpighi, born near Bologna in 1628 (died, 1694), Professor of Medicine at Bologna, and afterwards at Pisa, is justly regarded as the founder of Microscopic Anatomy; for he was the first who in his researches greatly availed himself of the aid of the microscope. He first clearly described the structure of the tongue and of the skin, demonstrating that it is everywhere beset with delicate papillæ, the chief organs of touch. He also discovered the rete mucosum (*rete Malpighii*), while his name is also associated with the Malpighian bodies in the spleen and kidneys. Malpighi was also the first who examined the circulation with the microscope. Among his chief works may be mentioned, 'De Cerebro;' 'De Lingua;' 'De Externo Tactus Organo;' 'Marcelli Malpighi Opera Omnia,' London, 1686.

Anton van Leuwenhoeff (born at Delft, 1638; died, 1723), and Johann Swammerdam (born at Amsterdam, 1637; died, 1680), acquired great reputation by their researches in natural history by means of the microscope. The latter introduced a new method of injecting the vessels—an art which was carried to great perfection by Frederick Ruysch (born at the Hague, 1638; died in 1731). By this contrivance the arrangement of minute vessels became visible to the naked eye. There was scarcely any part of the human body Ruysch did not inject, and he thus discovered many particulars relating to the minute structure of the lungs, the brain and its membranes, &c. By great labour Ruysch collected an anatomical museum, the first of the kind, which he sold in 1698 to Peter the Great for 30,000 florins. A considerable portion of this museum became useless in consequence, it is said, of the sailors having drunk the spirits in which the specimens had been preserved ('Ruysch F. Opera Omnia Anatomico-Medico Chirurgica,' Amst. 1737, 5 vols. 4to.).

Heinrich Meibom (Meibomius) (born at Helmstaet in 1590; died 1655) rediscovered the palpebral glands which bear his name ('De Vasis Palpebrarum Novis Epistola,' Helmstaedt, 1666). Johann Conrad Brunner (born near Schaffhausen, in 1653; died in 1727) discovered the glands named after him ('De Glandulis Duodeni,' Heidelberg, 1687). Johannes Conrad Peyer (born at Schaffhausen, 1653; died, 1712) discovered and described the solitary and agminated glands which bear his name ('Exercitatio Anatomico-Medica de Glandulis Intestinorum,' Schaffhusii, 1677).

Joseph-Guichard Duverney (1648–1730) and Raymond de Vieussens (1641–1715) are worthy representatives of French anatomy of this period. The former especially distinguished himself by his excellent treatise on the organ of hearing ('Traité de l'Organe de l'Ouie,' Paris, 1683), and the latter by the publication of his great work, 'Neurologia Universalis,' Lyons, 1685.

About this period, William Cowper (1666–1709) published his 'Myotomia Reformata,' London, 1694. Cowper distinguished himself also by his minute account of the urethral glands, which, although already known, especially to Méry, still bear Cowper's name. Edward Tyson (1649–1708) deserves special mention as one of the first English physicians to whom comparative anatomy is much indebted ('The Anatomy of a Pigmy Compared with that of a Monkey, an Ape, and a Man,' London, 1699).

Samuel Collins, the contemporary of Tyson, published about the same time an important work bearing the title 'Systema Anatomicum of the Body of Man, Birds, Beasts, Fishes,' &c., London, 1685.

Antonio-Marca *Valsalva* (1660–1723), the pupil of Malpighi, J. D. *Santorini* (1681–1737), and J. B. *Morgagni* (1682–1771), were at that period the representatives of anatomy in Italy. The treatise of Valsalva on the human ear ('De Aure Humani Tractatus,' &c., Bologna, 1704) was the most complete which had heretofore appeared on that subject. Santorini's anatomical observations ('Observationes Anatomicæ,' Venet. 1724) on the muscles of the face (*risorius Santorini*), on the brain, the organs of generation (circular fibres of Santorini), are all distinguished by their precision and novelty. Morgagni (1682; died, 1771), although better known and more appreciated as a pathological anatomist from his great work, 'De Sedibus et Causis Morborum' (Naples, 1761), and his 'Adversaria Anatomica' (Padua, 1741), proved a copious spring from which succeeding anatomists abundantly helped themselves.

Bernard Siegfried *Albinus* (1697–1770) greatly distinguished himself by the publication of his magnificent works, 'De Ossibus Corporis Humani,' Lugd. Batav. 1726, and especially by his 'Historia Musculorum Hominis,' Lugd. Batav. 1734. In this latter work he properly classified the muscles and applied to them names most of which have been adopted by anatomists. In association with Albinus must be mentioned his great pupil and successor, Albert *Haller* of Bern (1708–1777). Although the reputation of Haller chiefly rests upon his great work on physiology ('Elementa Physiologica Corporis Humani,' Lausanne, 1757), he, nevertheless, contributed largely to the progress of anatomy by the publication of various anatomical dissertations, among which may be mentioned 'Opera Minora Emendata, Aucta et Renovata Anatomica,' &c., 3 vols., Lausanne, 1762–1768.

Johann Friedrich *Meckel* (1713–1774), a favourite pupil of Haller, among other works, published a masterly description of the facial nerves, 'Tractatus de Quinto Pare Nervorum Cerebri,' Goett. 1748. Johann Gottfried *Zinn* (1727–1759) published an important treatise on the eye, 'Descriptio Anatomica Oculi Humani,' &c., Goettingen, 1755. A second and much improved edition of this work was published by Wrisberg in 1780. Heinrich Aug. *Wrisberg* (1739–1808), Haller's successor at Goettingen, published a number of anatomical treatises, among which may be mentioned 'Observat. Anatomico-Neurologicarum de Nervis,' &c., Goett. 1800 (Wrisberg's ganglion—nerve of Wrisberg). Peter *Camper* (1722–1789), now chiefly known by his 'facial angle,' published a large number of treatises on comparative anatomy. His work, 'Demonstrationum Anatomico-Pathologicarum,' La Hay, 1760–62, is full of interesting remarks on the anatomy of the arm and the pelvis and their incidental diseases.

William *Hunter* (1718–1783) was the author of numerous essays in the 'Philosophical Transactions.' His principal work, on which he was engaged for many years, is his 'Anatomical Description of the Gravid Uterus,' illustrated with thirty-four plates, Birmingham, 1774. John *Hunter* (1728–1793), the younger brother of William Hunter, equally distinguished as anatomist and physician, contributed largely to the 'Transactions of the Royal Society.' His museum at the College of Surgeons, illustrative of human and comparative structure, sufficiently establishes his rank as an

anatomist and physiologist. Among his principal published works may be mentioned his 'Treatise on the Natural History of the Human Teeth,' 2 vols. 1771–78; also his 'Treatise on the Venereal Disease,' 1786.

Samuel Thomas *von Soemmering* (1755–1830) published in the year 1794 his excellent work, 'De Corporis Humani Fabrica,' Francf., 6 vols., originally published in German. A new edition of this important textbook, in eight volumes, with large additions by Bischoff, Henle, Theile, Valentin, and other eminent German anatomists and physiologists, was published between 1841 and 1844. This great work brings our anatomical knowledge down to 1844. The seventh volume, it may be mentioned, contains the history of the development in mammalia, including man.

Johann Christian *Reil* (1759-1813) greatly enriched the anatomy of the brain and the nerves by his articles in his 'Archiv für Physiologie' (Reil's Island).

France was not behind Germany in the cultivation of the science of anatomy. The 'Anatomie Générale appliquée à la Physiologie,' Paris, 1801, is perhaps the ablest work on that subject which France has produced in that period. François Xavier *Bichat* (1771–1802), the author of this truly great work, was, unfortunately for science, prematurely cut off in his thirty-first year by typhoid fever. With Bichat we may associate George *Cuvier* (1769–1832), the founder of palæontology, and the greatest zoologist of his time.

F. Joseph *Gall* (1757–1828), the founder of the system of phrenology, and J. Jasper *Spurzheim* (1776–1832), his associate in the prosecution of his researches, have both, whether their system be received or not, by their contributions to the structure of the brain and the cerebral nerves, as well as by their collections of psychological facts, conferred considerable benefits on anatomical science ('Anatomie et Physiologie du Système nerveux en Général et du Cerveau en Particulier,' 4 vols., Paris, 1809–1819).

Regnier *de Graaf*, born in Holland, 1641 (died, 1673), a pupil of Frances de le Boë (Sylvius), published in 1663 a treatise, 'Disputatio Medica de Natura et Usu Succi Pancreatici,' Lugd. Bat., 1673; and in 1672 his work, 'De Mulierum Organis,' &c., Lugd. Bat. These works gained him a great reputation as an anatomist (Graafian vesicles or follicles).

Other works on human anatomy were published in England at the commencement of the present century by the Monro's, John and Charles Bell, Gordon, all of Edinburgh University. Jones' Quain's excellent textbook, the eigth edition of which, edited by Sharpey and Thomson, still holds its own.

Comparative anatomy in Great Britain owes much to the labours of Richard Owen, A. Carlyle, Goodsir, Busk, W. H. Flower, Huxley and other writers of the present day; nor is it possible, limited as our space is, to name all the authors who have contributed to this branch of knowledge.

After the invention of the compound achromatic microscope by Frauenhöfer, the minute structural anatomy of the tissues and organs was almost created anew. Johannes Müller in Berlin published in 1830 a paper on the minute structure of the glands; Ehrenberg in Berlin, Purkinje, Prochaska and Valentin were all engaged in microscopic researches. Kiernan gave the first accurate account of the minute anatomy of the liver. M. J. Schleiden published in 1838 an interesting treatise on the

cellular structure of plants, which was followed up by a still more important work on the cellular structure of both plants and animals by Th. Schwann, Berlin, 1839, and laid the foundation of histology. Thus Harvey's principle, 'Omne vivum ex ovo,' was displaced by Virchow's law, 'Omnis cellula e cellula,' which in its turn may be modified by recent researches.

Max Schultze pointed out the identity between the sarcode substance of the lower organisms and the cell-contents in the higher animals, and gave to these substances the name protoplasm. He therefore contended that an envelope was not necessary for the existence of a cell.

Recklinghausen demonstrated in 1863 the so-called wandering cells, and Waller and Conheim the diapedesis of the blood-corpuscles.

With regard to the cellular theory and the doctrine of evolution, it may not be out of place to mention that Lorenz Oken (1779–1851), the great naturalist, had already in 1805 advanced the dogmas that 'The organic world has for its basis an infinity of *vesicles* (or *cells*). The first organic points are vesicles. . . . Plants and animals can only be metamorphoses of infusoria. . . . No organism is, nor has ever been created, which is not microscopic. . . . Whatever is larger has not been created but developed. . . . Man has not been created, but is developed.' These propositions appeared in Oken's treatise 'On Generation' ('Die Zeugung,' Frankf., 1805). With Oken must be associated Goethe (1750–1832), whose researches on the intermaxillary bone and the theory of the vertebrate nature of the skull, claimed also by Oken, contributed to the promotion of morphological science.

Jean Lamarck (1704–1829) promulgated in his 'Philosophie Zoologique de Paris,' 1809, the theory that all organised beings, from the lowest to the highest forms, were progressively developed from microscopic particles.

It is, perhaps, noteworthy that in the same year in which Lamarck's zoology appeared was born Charles Darwin, who in his works on 'The Origin of Species,' the 'Descent of Man,' &c., endeavours to explain how all existing species have descended from one or a few forms of life. It may be long before the controversies which the theories of development and evolution have excited are laid to rest.

Space, as already stated, will scarcely permit me to name the authors of valuable works on microscopic, comparative and descriptive anatomy which have appeared during the last twenty years. Tiedemann, Ernst von Baer (1792), Th. W. Bischoff, Reichert, Hyrtl, Henle, Rüdinger, Helmholtz, Luschka, Aeby, Meyer, Krause, Stricker, Hoffmann, Langer, Gegenbaur, Kolliker, Häckel, &c., in Germany; G. and E. Saint-Hilaire, Milne-Edwards, Sappey, Cruveilhier, &c., in France; Richard Owen, Goodsir, Allen Thomson, Parker, Struthers, Humphry, W. H. Flower, Huxley, Mivart, Rolleston, Turner, Goodsir, Ellis, and the two Quains, Sibson, Quekett, Beale, in England; Donders, Vrolik, Schroeder van der Kolk, in the Netherlands, are only a few of the many eminent men of those countries who have in recent times greatly contributed to the advancement of the science of anatomy.

BIBLIOGRAPHY.

WORKS ON THE HISTORY OF ANATOMY.

A. O. Goelicke, *Hist. Anat. Nova*, 1713. Gottlieb Stollen, *Einl. z. Hist. d. Med. Gelehrtheit*, 1731. A. Portal, *Histoire de l'Anat. et de la Chirurgie*, 6 vols., 1770-3. A. Haller, *Bibliotheca Anat.*, 1774-7. T. Lauth, *Histoire de l'Anat.*, 1815-16. Kurt Sprengel, *Versuch e. Prag. Geschichte d. Arzneikunde*, 5 vols., 1821-28. J. Hyrtl, *Antiq. Anat. rariores*, 1835, plates. A. Burggraeve, *Précis de l'Histoire de l'Anat.*, 1840. J. Hyrtl, *Geschichte d. Anat. an d. Prager Universität, &c.*, 1843. J. Hyrtl, *Geschichte d. Anat. an d. Wiener Universität* and *Vergangenheit und Gegenwart d. Museums, &c. d. Wiener Med. Facultät*, 1869. H. Hœser, *Geschichte d. Medicin*, 1875. C. Daremberg, *Histoire d. Sciences Médicales*, 1870. J. Rochard, *Histoire de la Chirurgie Française*, 19e siècle, 1875. Hoefer, *Histoire de l'Anat.* H. Rohlfs, *Geschichte der Deutschen Medicin*, 1875. F. Fredault, *Histoire de la Médecine*, 1873. G. Fischer, *Chirurgie vor 100 Jahren*, 1876. J. H. Baas, *Grundriss d. Geschichte der Medecin*, 1876. Dr. Wiseman, *History of Medicine among the Asiatics*, 1872. Dr. Meryon, *History of Medicine*. Dr. K. N. McDonald, *The Practice of Medicine among the Burmese*, 1879. *Archiv für Geschichte der Medicin*, by Rohlfs. Hyrtl, *Das Arabische und Hebraische in der Anatie.*, 1879.

PRACTICAL ANATOMY AND DISSECTION.

The preparation of bones, ligaments, and muscles is spoken of by the oldest anatomists in the following works:—Galen, *Administrationibus Anatomicis*. Carolus Stephanus (C. Etienne), *Dissection du Corps Humain*. R. Columbus, *De Re Anatomica*. J. Riolanus, *Encheiridium Anatomicum*. Mich. Lyser (the pupil of Th. Bartholin), *Culter Anatomicus*, 3 editions from 1653 to 1731. A. Monro, *Tentamenta circa Methodum Partes Animantium affabre injiciendi, easque bene conservandi, &c.*, 1741. J. F. Cassebohm, *Methodus secandi, &c.*, a posthumous work. C. P. Fabricius, *Methodus cadavera Humana rite secandi*, 1778. J. Lieutaud, *Essais Anat., contenant l'Histoire exacte de toutes les parties, &c.*, 1742. T. Pole, *Anatomical Instructor*, 1790. J. L. Fischer, *Anweisung zur Praktischen Zergliederungskunst*, 1791. J. A. Orchy, *Anweisung zur zweckmässigen zierlichen Leichenöffnung und Untersuchung*, 1802. C. Dumeril, *Essai sur les Moyens de perfectionner et étudier l'Art de l'Anatomiste*, 1803. J. N. Marjolin, *Manuel d'Anatomie*, 1812-15. J. P. Maygrier, *Manuel de l'Anatomiste*, 1818. A. M. Meyer, *Praktische Anleitung zur Zergliederung des Menschlichen Körpers*, 1822. J. M. Staupa, *Anweisung zur Gerichtlichen und Pathologischen Untersuchung Menschlicher Leichname*, 1827. C. Bock, *Die Prosector, &c.*, 1829. M. J. Weber, *Die Zergliederungskunst des Menschlichen Körpers*, 1826-32. A. Lauth, *Neues Handbuch der Praktischen Anat.*, 2 vols., 1835-6. M. J. Weber, *Handbuch d. Anat. des Menschlichen Körpers*, 1845. G. Valentin, *Die Kunstgemässe Entfernung der Eingeweide*, 1857. Keen's *History of Anatomy*. C. Hesselbach, *Vollständige Anleitung z. Zergliederungskunde*, 1st vol., 1805. Keen, *Philadelphia School of Anatomy*. J. H. Green, *Dissector's Manual*, 1820. J. Shaw, *Manual for the Student of Anatomy*, 1821. J. F. South, *The Dissector's Manual*, 1825. M. J. Weber, *Elemente d. allg. u. spec. Anat., mit d. Zergliederungskunst*, 1826-32. A. C. Bock, *Der Prosector*, 1829; *The Edinburgh Dissector*, 1820? E. A. Lauth, *Nouveau Manuel de l'Anatomiste*, 1836. E. Wilson, *The*

Dissector's Manual, &c., 1853. L. W. Bischoff, *Anleitung zum Seciren*, 1856, and recent edition, 1873. J. Budge, *Anleitung z. den Präparirübungen*, 1866. Straus-Durckheim, *Traité Pratique et Théorique d'Anat. Comparative*, 2 vols., 1842. J. Hyrtl, *Handbuch d. Zergliederungskunst*, 1860, and *Corrosions-Anat.*, 1873? G. H. Meyer, *Anleitung z. den Präparirübungen*, 3rd ed., 1873. R. Harrison, *The Dublin Dissector*, 2 vols., 5th ed. T. H. Ledwich, *Practical and Descriptive Anatomy, &c.*, 1876. L. Holden, *Manual of the Dissection of the Human Body*, 3rd ed. J. V. Ellis, *Demonstrations of Anatomy*, 9th ed., 1878. Horner, *United States Dissector*. C. Heath, *Manual of Practical Anatomy*, 4th ed., 1878. Dr. Cleland, *Directory for the Dissection of the Human Body*, 1877. Smith, *United States Dissector*. Dr. Cunningham, *Guide to Dissection*. Tulk, *Anatomical Manipulation*, 1820? Carrington, *Manual of Dissections*, 1881. Auffret, *Dissections des Régions*, 1881. Le Prieur, *Recherches sur la Conservation temporaire des Cadavres*, 1873.

Bones and Ligaments.—J. A. Bogros, *Quelques Considérations sur la Scèletopée*, 1819. J. Cloquet, *De la Scèletopée, &c.*, 1849. Most of the various English and foreign works on descriptive anatomy contain rules for regional dissection, but there is no special work on dissection in French or German similar to the best English models, as the students dissect the various systems—*i.e.* the ligaments, muscles, vessels, nerves, &c.—separately and at different terms of their curriculum.

WORKS ON DESCRIPTIVE AND SYSTEMATIC ANATOMY AND ANTHROPOLOGY.

Only the most important and original more modern works need here be mentioned, as well as all recent books. J. F. Meckel, *Handbuch d. Menschlichen Anat.*, 4 vols., 1815–20. F. Hildebrandt, *Lehrbuch d. Anat. d. Menschen*, by E. H. Weber, 1830–32, 4 vols. Th. Sömmerring, *Vom Bau d. Mensch. Körpers*, 9 vols., assisted by several German anatomists. M. J. Weber, *Vollständiges Handbuch d. Anat.*, 1845, 3 vols. F. Arnold, *Handbuch d. Anat. d. Menschen*, 1843–51. H. Luschka, *Anat. d. Menschen*, 3 vols., 1862–66. The *Handbooks* of H. Meyer, 3rd ed., 1873; C. Langer, 1870?; C. Eckhard, 1862; Aeby of Bern and L. Hollstein, 5th ed., 1872. J. Henle, *Handbuch d. Systematischen Anat. d. Menschen*, 9 parts, 2nd ed., 1868–75. J. Cruveilhier, *Traité d'Anatomie Descriptive*, by Marc Sée and Cruveilhier's son, 1867–74, 7 parts. C. Sappey, *Traité d'Anatomie Descriptive*, 1869–74, 4 vols. C. F. T. Krause, *Handbuch d. Anat.*, 3rd ed. by W. Krause, only vol. i. has yet appeared, 1876. Beaunis and Bouchard, *Nouveaux Eléments d. Anat. Descriptive*, 3rd ed., 1873. A. Jamain, *Nouveau Traité Elémentaire d'Anat. Descriptive*, 1876, 3rd ed. J. A. Fort, *Anatomie et Dissection*, 3rd ed., 1875. *Quain's Anatomy*, 8th ed., by Sharpey, Thomson, and Schäefer, 2 vols., 1876. T. Gray's *Anatomy, Descriptive and Surgical*, 8th ed., by T. Holmes, 1877. Erasmus Wilson, *The Anatomist's Vade Mecum*, 9th ed., 1873, by Buchanan. W. Turner, *Introduction to Human Anatomy*, 1877. J. Hyrtl, *Lehrbuch d. Anat. d. Menschen*, 12th ed., 1873. Leidy's *Descriptive Anatomy* (American). W. Gruber, *Abhandlungen aus d. Mensch. u. Vergleichenden Anat.*, 1852. G. A. Ruhff, *Le Corps Humain, &c.*, 1878. J. N. Massé, *Traité pratique d'Anat. Descriptive*, 1858. G. Retzius, *Anatomische Untersuchungen*, 1872. Dwight, *Anatomy of the Head*. E. Serres, *Recherches d'Anat. Transcendante, &c.*, 1832. J. Kollmann, *Mechanik d. Menschlichen Körpers*, 1874. Agnew's *Anatomy* (American). Draper's *Anatomy* (American). Gove's *Anatomy* (American). Handy's *Anatomy* (American). Hartshorne's *Anatomy* (American). Horner's *Anatomy* (American). Morton's *Anatomy* (American). Richardson's *Anatomy* (American). Leyh, *Anat. des Animaux Domestiques*. *Archivio per l'Antropologia e la Etnologia*, P. Mantegazza. Retzius, *Med. Chir. Review*, 1860, i. 503. Cooke's *Tablets of Anatomy*. Bale, *Student's Anatomy*, 1879. C. E. E. Hoffmann, *Lehrbuch der Anat. des Menschen*, 2nd ed., 4 vols., 1877. Haeckel's *Anthropogenie* and his *Schöpfungsgeschichte*. Humboldt's *Cosmos*. Latham's works. Bruce, *Races of the World*. Agassiz, *Races of Man*. The works of John and Wm. Hunter, Sir C. Bell, Goodsir and Struthers, Quetelet and Quatrefages. J. M. Langenbeck, *Handbuch d. Anat.*, 1826–38. P. Topinard, *L'Anthropologie*, 1876. Waitz, *Anthropologie*. Ewart's *Anatomy*, announced. Pritchard, *Natural History of Mankind*. R. Brown, *The Races of Mankind*. L. Figuier, *The Human Race*. W. Lawrence, *The Comparative Anatomy, &c., of Man*. Buckle, *History of Civilisation*. Carl Vogt, *Vorlesungen über den Menschen*. C. Mivart, *Evolution of Species*. Roberts, *Anthropometry*, 1878. Dr. Ransome's *Stethometry*. Huxley,

Anatomy of Vertebrate Animals. Owen, *Comparative Anatomy.* Rolleston, *Forms of Animal Life.* Gegenbaur, *Elements of Comparative Anatomy.* McAlister, *Animal Morphology.* Chauveau, *Comparative Anatomy,* by Fleming. F. Blumenbach, *De Generis Humani Varietate Nativa.* 1795. C. H. Smith, *Natural History of the Human Species,* 1848. C. Nott and R. Gliddon, *Types of Mankind.* Huxley, *Man's Place in Nature,* and the works of C. Darwin and Wallace, Combe, Miller, R. Murchison, and Lyell. Hartmann, *Handbuch der Anat. des Menschen,* 1880. Moynac, *Manuel d'Anat. descriptive.* Pansch, *Grundriss d. Anat. d. Menschen,* 1880. Tylor, *Anthropology,* 1881. Darling and Ranney, *Essentials of Anatomy,* 1881 (American). Mears, *Schematic Anatomy,* 1881. C. Langer, *Lehrbuch d. Anatie. d. Menschen,* 2nd ed. (announced). Drury, *Lehrbuch d. Anatie.,* 1863.

ANATOMICAL DICTIONARIES.

H. T. Schreger, *Synonymik d. Anat. Literatur,* 1803. J. Barclay, *New Anat. Nomenclature,* 1803. J. F. Pierer and L. Choulant, *Medicinisches Realwörterbuch,* 1816-29; *Encyclopädisches Wörterbuch der Med. Wissenschaften,* 1828, &c.; *Cyclopædia of Anat. and Phys.,* Todd and Bowman. R. Wagner, *Handwörterbuch der Physiologie,* 4 vols., 1842-53; and anatomical articles in the Old French medical dictionaries and those of Dechambre, Littré et Robin, Bouchut et Després, 3rd ed., 1877, Bouley et Regnal, 1865-74. Jaccoud, 1864–78. Griffith and Henfrey's *Micrographic Dictionary.* F. Richter, *Encyclopädie d. Anatomie,* 1841.

ATLASES.

Old tables by Albinus, Caldani, Cloquet, Sandifort and Loder, and old Italian plates. Cowper, Versalius, *Anatomia Universa,* 44 tables, 1823. Lizar's *Atlas of Anat.* J. Quain and Erasmus Wilson's *Plates.* Bourgery and Jacob's *Atlas.* Bonamy and Beau's *Atlas.* J. M. Langenbeck, *Icones Anatomicæ,* 1826–38. M. J. Weber, *Anat. Atlas,* 2nd ed. F. Arnold, *Tabulæ Anatomicæ,* 1838–43. R. Froriep, *Atlas Anatomicus, &c.,* 4th ed. E. Bock, *Handatlas d. Anat.,* 7th ed. (English). N. Massé, *Handatlas,* 2nd ed. C. Heitzmann, *Descriptive u. Topograph. Anat.,* 1875, 2nd ed. J. Henle, *Handatlas,* 1871-75. *Traité complet de l'Anat. de l'Homme, avec Atlas,* by Bourgery and Jacob, 1868. A. Ecker, *Icones Physiologicæ.* J. V. Ellis, *Illustrations of Dissections.* Dr. Sibson's *Medical Anatomy.* Dr. Savage's *Anatomy of the Female Organs.* J. R. Godlee, *Anatomical Atlas,* recent. T. Rüdinger's *Plates of Nerves, Ear, &c.* Flower's *Plates of the Nerves.* W. Henke, *Atlas d. Topograph. Anat.,* 1867. Klein and E. N. Smith, *Atlas of Histology.* G. H. Meyer, *Kleiner Anat. Atlas,* 1877. Lambert's *Anat. Plates* (American). Smith's *Anat. Atlas* (American). Trall's *Anat. Charts* (American). Wenzel, *Anatomischer Atlas,* macro- and microscopic. Politzer, *Wandtafeln d. Anat. d. Gehörorgans.* Witkowski, *Anat. Iconoclastique,* of which a translation is in preparation. Dr. Faber's *Phantom d. Brust- u. Bauch-Eingeweide, u. d. Gehirn,* English translation. Eckhardt, *Le Corps Humain.* Pansch, *Die Furchen u. Wülste am Grosshirn.* Dursy, *Menschlichen Gehirn, &c.* Obst, *Anat. Atlas.* Cutter's *Anatomical Charts.* Fiedler's *Anat. Plates.* E. N. Smith's *Anatomical Atlas* (chiefly a reproduction of Heitzmann's *Atlas*). 1880. Wenzel, *Atlas d. Gewebelehre d. Menschen, &c.,* 1879. Duval, *Atlas Général d'Anat. descriptive.*

GENERAL ANATOMY AND HISTOLOGY.

T. Schwann, *Mikroscopische Untersuchungen, &c.,* 1839. J. Henle, *Allgemeine Anat.,* 1841. A. Kölliker, *Handbuch d. Gewebslehre, &c.,* 1867. H. Frey, *Histology and Histochemistry of Man,* by Barker, and *The Microscope and Microscopic Technology,* by Cutter, both recent. G. Valentin, *Untersuchung d. Pflanzen- und Thiergewebe, &c.,* 1861. Beale, *How to Work with the Microscope,* and *The Microscope in Medicine,* 1878. A. Béclard,

Éléments d'Anat. Générale. Bichat, *Anat. Générale.* Claude Bernard, *Propriétés des Tissus Vivants.* F. Leydig, *Histologie des Menschen und Thiere*, 1857. A. Kölliker, *Icones Histologicæ.* Stricker's *Human and Comparative Histology*, translated by the New Sydenham Society. T. Hessling, *Allgemeine u. Spec. Gewebelehre d. Menschen*, 1866. C. Robin, *Anat. Microscopique*, and *Traité du Microscope*, 1873. C. Morel, *Traité Élémentaire d'Histologie Humaine, &c.*, 1864. Articles on minute anatomy will be found in Todd and Bowman's *Cyclopædia*, Quain's *Anatomy*, and in Henle's, Sappey's, Cruveilhier's, and Krause's *Anatomy.* J. A. Fort, *Traité Élémentaire d'Histologie.* Pouchet et Tourneux, *Précis d'Histologie, &c.* L. Ranvier, *Traité Technique d'Histologie.* C. Toldt, *Lehrbuch d. Gewebelehre*, 1877. A. Donné, *Cours de Microscopie* and *Atlas*, 1844–6. Klein and E. N. Smith's *Atlas of Histology.* C. J. M. Langenbeck, *Mikros. Anat. Abbild.*, 1850. Toldt, *Gewebelehre d. Menschen*, 1878. Wythe, *The Microscopist.* L. Mandl, *Anatomie Microscopique*, 1857. Griffith and Henfrey's *Micrographic Dictionary.*

TOPOGRAPHIC ANATOMY.

Several old English copper-plates and the works of Allan Burns, Lizars, Sir C. Bell, Paltin, Heister, Paré, and Portal. Milne Edwards, *Manuel d'Anat. Chirurgicale*, 1826. E. Wilson, *Practical and Surgical Anat.*, 2nd ed. M. Velpeau, *Manuel d'Anat. Chirurgicale*, 1837. P. E. Blandin, *Traité d'Anat. Topographique*, 2nd ed., 1837. J. F. Malgaigne, *Traité d'Anat. Chirurgicale*, 1837. J. E. Pétrequin, *Traité d'Anat. Medico-chirurgicale*, 2nd ed., 1857. F. Jarjavay, *Traité d'Anat. Chirurgicale*, 2 vols., 1852-54. A. Richet, *Traité Pratique d'Anat. Med.-chirurgicale*, 4th ed., 1873. Le Gendre, *Anatomie Chirurgicale Homolographique*, 1858. B. Anger, *Nouveaux Éléments d'Anat. Chir.*, with atlas, 1869. The older works of Seeger and Nuhn. J. Hyrtl, *Handbuch d. Topographischen Anat., &c.*, 2 vols., 6th ed., 1872. W. Roser, *Chirurgisch-anatomisches Vademecum*, by Galton. G. Ross, *Handbuch d. Chirurg. Anat.*, 1848. F. Führer, *Handbuch d. Chirurg. Anat. mit Atlas*, 1857. J. Engel, *Compendium d. Topograph. Anat.*, 1860. Plates of surgical anatomy by Bierkowsky, Nuhn, Froriep, Pirogoff, Maclise, Henke, and Braune's recent work translated by Bellamy. Béraud, *Anat. Chirurgicale.* L. Holden, *Surgical Landmarks.* P. Tillaux, *Traité d'Anat. Topographique.* Chiene, *Surgical Anat.* Bernard and Huette's work translated by Norton. Cauvet, *Anatomie Topographique.* Paulet et Sarazin, *Traité d'Anat. Topographique*, 1866–9. Paulet, *Anat. Appliquée.* B. Anger, *Traité Iconographique des Maladies Chirurgicales*, 1866. Rüdinger, *Topographisch-chirurg. Anat.*, 1873–8. Henke, *Topographisches Anat.* Chavernac, *Anat. Chirurgicale.* Mortara, *Lezioni di Anatomia Topographica*, 1880. Favaloro, *Manuale di Anatomia Topographica*, 1879. Hoffmann, *Die Körperhöle d. Menschen, &c.*

ARTISTIC ANATOMY.

Only the best of these works need here be mentioned. E. Harless, *Lehrbuch d. Plastischen Anat.*, 2nd ed., 1876. J. B. Leveillé, *Méthode nouvelle d'Anat. Artistique*, 1863. C. Roth, *Plastisch-Anat. Atlas*, 1870. F. Berger, *Handbuch d. Anat. für bildende Künstler*, 3rd ed. 1867. Lavater's *Physiognomy of Expression* and Sir C. Bell's *Anatomy of Expression.* P. N. Gerdy, *Anat. des Formes Extérieurs du Corps Humain*, 1829. J. Fau, *Anat. des Formes du Corps Humain, &c.*, 1866, and *Artistic Anat.* by Knox. Marshall, *Anatomy for Artists*, 1878. C. Darwin, *The Expression of the Emotions in Man and Animals.* Bonomi, *Anat. Artistique.* Flaxman, *Elementary Anat. Studies, &c.* Muckley, *Student's Manual of Artistic Anatomy.* Cleland, *Evolution and Expression.* A. Froriep, *Anat. für Künstler*, 1880.

PERIODICALS.

Reil's *Archiv*, 12 vols. Meckel's *Deutsches Archiv für Physiologie*, 8 vols. Meckel's *Archiv für Anat. und Phys.*, continued by J. Müller in 1858 and then by Reichert and

Du Bois Raymond. Siebold and Kölliker's *Zeitschrift für Wissenschaftliche Zoologie.* Virchow's *Archives.* M. Schultze and Waldeyer's *Archiv für Mikroscopische Anat.* Henle and Canstatt's *Jahresbericht über die Fortschritte d. Anat., &c.* Schmidt's *Jahrbücher. The Journal of Anat. and Phys.*, by Humphry. *Archives de Physiologie Normale et Pathologique. Journal de l'Anat. et Physiologie.* by Robin. *Transactions of the Royal Society* and of other British, foreign, and American associations and societies. *American Journal of Microscopy. Monthly Microscopical Journal. Quarterly Journal of Microscopy.* Hoffmann und Schwalbe's *Jahresberichte der Anat. und Phys.* Pflüger's *Archiv d. gesammten Phys.*, 16 vols. *Archiv d. Phys. Chemie u. Mikroscopie*, 1844–47. Stricker's *Medicinische Jahrbücher. Laboratoire d'Histologie*, by Bernard et Ranvier. Gegenbaur, *Morphologisches Jahrbuch. Comptes rendus de Biologie. Mittheilungen d. Anthropologischen Gessellschaft in Wien. Zeitschrift für Anat. und Entwickelungsgeschichte*, by His and Braune. *Zeitschrift für Biologie*, by Buhl, Pettenkofer, and Voit. *Versammlung d. Deutschen Gesellschaft für Anthropologie, Ethnologie und Urgeschichte. Centralblatt für die Medicinischen Wissenschaften. Medicinische Chirg. Rundschau. London Medical Record. Memorabilien. Journal of the Anthropological Institute. Bulletins de la Société d'Anthropologie. Revue d'Anthropologie.* P. Broca, *Annales des Sciences Naturelles. Archives des Sciences Physiques et Naturelles. Zeitschrift für Ethnologie. Bulletin de l'Académie Royale de Belgique. Comptes rendus de l'Académie des Sciences de Paris. Giornale Internazionale delle Scienze Mediche. Archivio per l' Antropologia e l' Etnologia*, Mantegazza. *Transactions of the American Society of Anatomy, &c.*

For the literature of the special departments of anatomy, such as osteology, arthrology, myology, &c., the student must refer to systematic works on anatomy or to special treatises.

CHAPTER II.

INTRODUCTORY OBSERVATIONS.

The Science of Morphology (*μορφή=form* or *structure*, and *λόγος=discourse*), or Anatomy (*ἀνὰ=apart*, and *τέμνω=I cut*), is a division of that branch of natural science which deals with the organisation of living beings (and is therefore properly called *Biology*, *βιούς=living*, and *λόγος=discourse*), and is naturally divisible into various departments, such as that of *Human Anatomy*, with which the present work deals; *Comparative Anatomy*, which undertakes the study of the structure of different animals, comparing and contrasting them; *Vegetable Anatomy*, which comprehends the examination of plant structure; and *Mineral Anatomy*, if I may be allowed the expression, which deals with the structure and composition of the inorganic kingdom. Recent researches have shown that there is a definite plan of structure, subject to various modifications, even in the so-called inorganised, *third*, or lowest kingdom of nature.

Human Anatomy forms a part of the larger science of Anthropology or Anthropography, and has various subdivisions. *Macroscopic Anatomy* deals with the naked eye appearances of the various systems, apparatuses and organs, and is called *Descriptive* or *Special Anatomy*; whereas *Microscopic Anatomy* or *Histology* (from *ἱστός=a web* or *tissue*) deals with the minute structure of the various systems and organs, and this branch of the subject has been called *General Anatomy*.

Histogenesis is that branch of minute anatomy which studies the origin and mode of formation of the elements and tissues.

General Anatomy may have its special departments, as Special Anatomy may have its general sections, e.g. the general part of general anatomy would deal with the description of elements which are common to many parts or organs; whereas the special part of general anatomy would deal with the minute structure of elements which are peculiar to certain tissues. The general part of special anatomy would deal with parts which are common to various portions of the body, and the special part of special anatomy has for its object the study of the special structures which are peculiar to certain organs, apparatuses, or regions.

Special or Descriptive Anatomy may be treated of in three ways: 1, the *Analytical*, obtained by dissection, and called *Anthropotomy*; 2, *Synthetical* or *Systematic*, in which the study is begun with the bones and continued with the ligaments, muscles, vessels and nerves, &c., as in ordinary handbooks of anatomy; and 3, *Topographical* or *Regional Anatomy*, in which method certain parts or regions of the body are studied in their entirety, and cognisance is taken of the relations and contents of each part. This last department of anatomy has both a scientific and an important practical bearing, and has been divided into *Surgical*, *Medical*, and

Gynæcological anatomy, the last including the anatomy of the fœtus and child.

Anthropometry is the name given to the method which consists in measuring, weighing and comparing, or contrasting the various parts or organs of the human subject.

The ordinary descriptions furnished by the text-books are founded on the dissections of a large number of male and female adults, and are taken as the *norm*; but my view is, and I would impress it on the student, that before we can obtain the true norm, very many thousands more subjects must be carefully dissected; and the attentive worker will soon become convinced of this fact, because he will observe that in no two bodies are the parts and relations exactly alike, and to strike anything like a correct average, it is necessary to have an enormous number of accurate observations from which a correct mean must be drawn. Further, the element of 'personal equation,' which is a strong one, must be duly allowed for in drawing conclusions from the observations of different workers.

For the purposes of the practical surgeon, physician, and gynæcologist, the facts of ordinary adult and fœtal anatomy are sufficient; but to a thorough comprehension of the subject it is necessary to study the development of the embryo, and this forms another division of anatomy, which is termed *Embryology*. The student must refer to his systematic books, or to the various monographs on the subject of human and comparative development, for this branch of the subject; but the anatomy of the fœtus will be given in a separate section of this work.

Anthropotomy, or *Practical*, or *Technical Anatomy*, deals with the method of dissecting the body, of preparing it prior to dissection, and of preserving the various organs and parts for the museum.

Applied Anatomy is, as the term would convey, the application of anatomical facts, and especially of the relations of the various organs and parts to each other, to the practical purposes of the surgeon, physician, and obstetrician, and may be accordingly divided into surgical, medical and obstetric anatomy, the last including the anatomy of the fœtus.

Physiological or *Textural Anatomy* is synonymous with general anatomy, and deals with the minute structure of organs, preparatory to studying their uses or functions.

Artistic or *Plastic Anatomy* comprehends, chiefly, the study of the external configuration of the body, its prominent bony and soft markings and depressions, and the changes produced by muscular action, and is studied by those desiring to excel in the delineation of the forms, the expression of the countenances, and the modifications of the figures of man and the lower animals.

Forensic Anatomy deals with the changes produced in the body by occupation, climate, injury, and other causes, and if these be produced by disease or poisons, it becomes a branch of the science of *Pathological Anatomy*.

Teratological Anatomy has to do with the structure of monstrosities, whether due to deficient or excessive development, and may best be considered a branch of embryology, or of pathological anatomy.

Anatomy may be studied from two chief standpoints, the *morphological*, and the *physiological*. In the morphological study the various branches of anatomy are called into play to aid in the elucidation of

general principles with regard to the construction of the human body and that of the lower animals. To attain to the laws of morphology, it is necessary to combine an extensive and accurate knowledge of the anatomy of man and animals with the study of development and evolution. In the physiological method, the materials relating to the structure of the various parts are furnished by anatomy, and an explanation of the functions or uses of these parts or organs is sought by the experimental and practical physiologist.

Another most important branch of the subject, which, although in its veriest infancy, has made great strides during the last decennium, is *Phylogenesis*, *Ætiology*, or *Evolution*, which deals with the origin of the lower animals from yet lower forms, and of man from some inferior predecessor. Phylogenesis studies the geneological pedigree of large groups of the animal and vegetable kingdoms or of the entire kingdoms, while *Ontology* or *Ontogenesis* pays regard to the evolution of the individual.

Anthropology is another most important branch of the subject, or, more correctly speaking, Human Anatomy is a branch of the science of Anthropology, which deals with the structure, distribution, habits, &c., of the various races of mankind in the present as well as in the past.

If *Fossil Anatomy*, that is, the study of what is found in the earth of the hard parts of man and animals, be the subject of consideration, it is called *Palæontological Anatomy*.

Veterinary Anatomy is that portion of *Zoology and Comparative Anatomy* which deals with the structure of domestic animals.

Ethnology is a branch of *Anthropology*, and deals with racial differences. As, in connection with a work like the present on practical anatomy, the student must study some systematic works, he must refer to them for considerations as to plans of organisation, for the various divisions of descriptive anatomy, for an explanation of the descriptive terms, and for classification and nomenclature.[1]

THE HUMAN BODY IN GENERAL.

The student before proceeding to dissection must have a general idea of the external conformation of the body, as it will help him in the study of its various regions, and it will aid in the comprehension of the position and relations of the various contents of these regions when he is proceeding with their dissection.

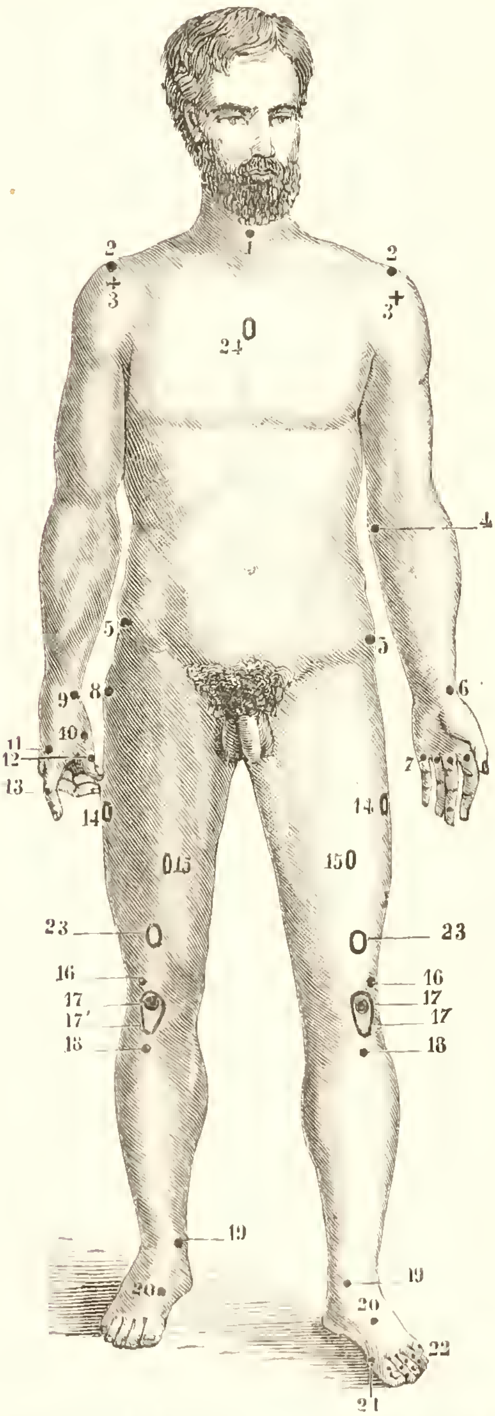
The human body is externally composed of two nearly symmetrical portions, there being a slight predominance in the majority of cases on the right side. It is naturally divisible into the head, neck, trunk, and limbs, and each of these segments is again divisible into a certain number of secondary regions, which are more or less limited, and each of which presents a peculiar conformation. The study of these regions forms what is called *external anatomy*, or the anatomy of the form, and this, with the study of muscular action, constitutes the essentials of *Artistic Anatomy*.

The popular conception of human morphology divides the body into,

[1] It will suffice to state that in my opinion the systematic divisions should be Osteology for a description of the bones; Arthrology for the joint surfaces; Syndesmology for the ligaments; Myology for the muscles; Angeiology for the blood and lymph vessels; Neurology for the nervous system; Splanchnology for the viscera; Æsthesiology for the organs of special sense; and Embryology for the development of the fœtus. I think that the term Sarcology would be much preferable to Myology.

the head, the neck, the trunk or body, the arm, and the leg; but a more accurate description of the external form is the anatomical one, which is the following:—

1. The **Head**, divided into skull or *cranium*, and face or *facies*.
2. The **Neck**.



1. Episternal notch.
2. Acromion.
3. Head of humerus.
4. Int. condyle.
5. Ant. sup. spine of ilium.
6. Radial artery at wrist.
7. Bifurcation of digital arteries.
8. Great trochanter.
9. Styloid process of radius.
10. Base of thumb metacarpal.
11. Head of index ,,
12. Base of first phalanx of thumb.
13. Head ,, ,, index.
14. Junction of upper and middle thirds of femur.
15. Middle of femur.
16. Outer condyle of femur.
17. Patella.

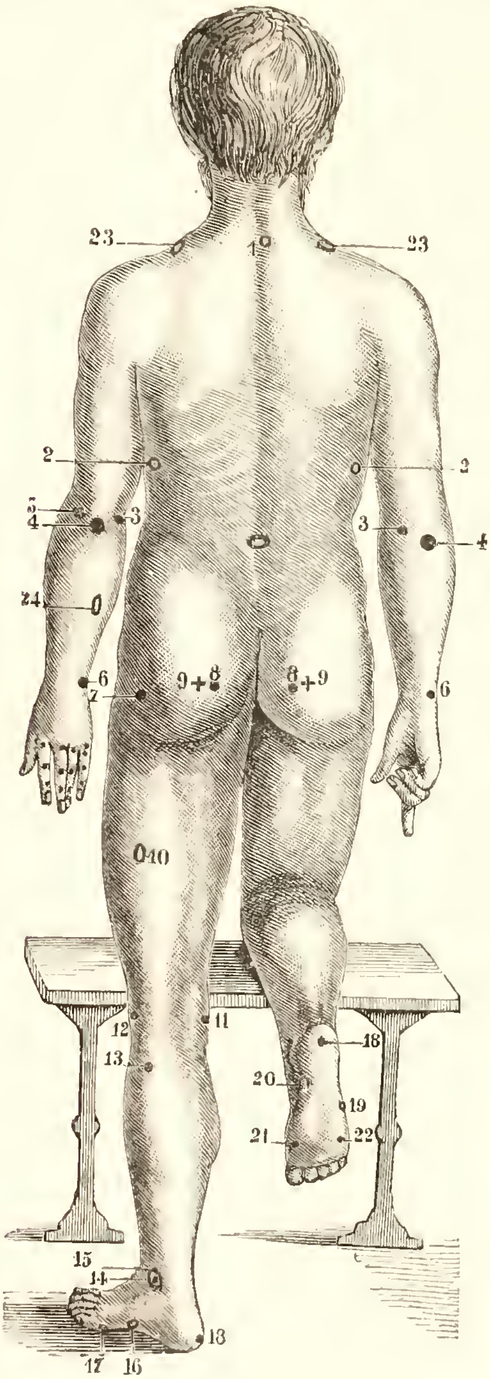
17′. Tubercle of tibia.

18. Beginning of ant. tib. artery.
19. Post. tib. artery at ankle.
20. Dorsalis pedis artery.
21. Metatarso-phalangeal joint of great toe.
22. Digital arteries of toes.
23. Over tendon of quadriceps extensor.
24. Over middle of sternum.

FIG. 1.—DIAGRAM OF MOST OF THE PROMINENCES AND GROOVES ON THE FRONT OF A MALE BODY.

3. The **Trunk**, divided into the *thorax*, breast or chest, and the *abdomen* or belly, the lower portion of which is the *pelvis*.
4. The **Upper extremity**, which is divisible into the shoulder or *axilla*,

the arm or *brachium*, the elbow or *cubitus*, the forearm or *antibrachium*, the wrist or *carpus*, and the hand or *manus*, consisting of the middle hand or *metacarpus*, and the fingers, which are the thumb or *pollex*, the first finger or *index*, the middle finger or *digitus medius*, the ring finger or *digitus annularis*, and the little finger or *digitus minimus*.



1. Seventh cervical vertebra.
2. Tenth intercostal space.
3. Int. condyles.
4. Olecranon.
5. Ext. condyle.
6. Styloid process of ulna.
7. Great trochanter.
8. Sciatic artery.
9. Gluteal ,,
10. Over biceps femoris.
11. Beside inner hamstrings.
12. ,, outer ,,
13. Over head of fibula.
14. ,, ext. malleolus.
15. ,, peronei.
16. ,, base of fifth metatarsal.
17. ,, head ,, ,,
18. ,, insertion of tendo Achillis

19, 20 } Direction of plantar arch.

21, 22 } Bifurcation of digitals.

23. Over post. scapular artery.

○. Corresponds to umbilicus.

FIG. 2.—DIAGRAM OF MOST OF THE PROMINENCES AND GROOVES ON THE BACK OF THE SAME BODY.

5. The **Lower extremity** is divisible into the hip or *coxa*, the thigh or *femur*, the knee or *genu*, the leg or *crus*, the ankle or *radiculus pedis*, and the foot or *pes*, consisting of, the heel or *calx*, and the instep or *dorsum pedis*, which is made up behind by the foot-root or *tarsus*, and in

front by the mid-foot or *metatarsus*, and the toes, which are, the great toe or *hallux*, the second toe or *digitus secundus*, the third toe or *digitus tertius*, the fourth toe or *digitus quartus*, the fifth and little toe or *digitus minimus*.

This anatomical survey corresponds to the bony skeleton, and to the

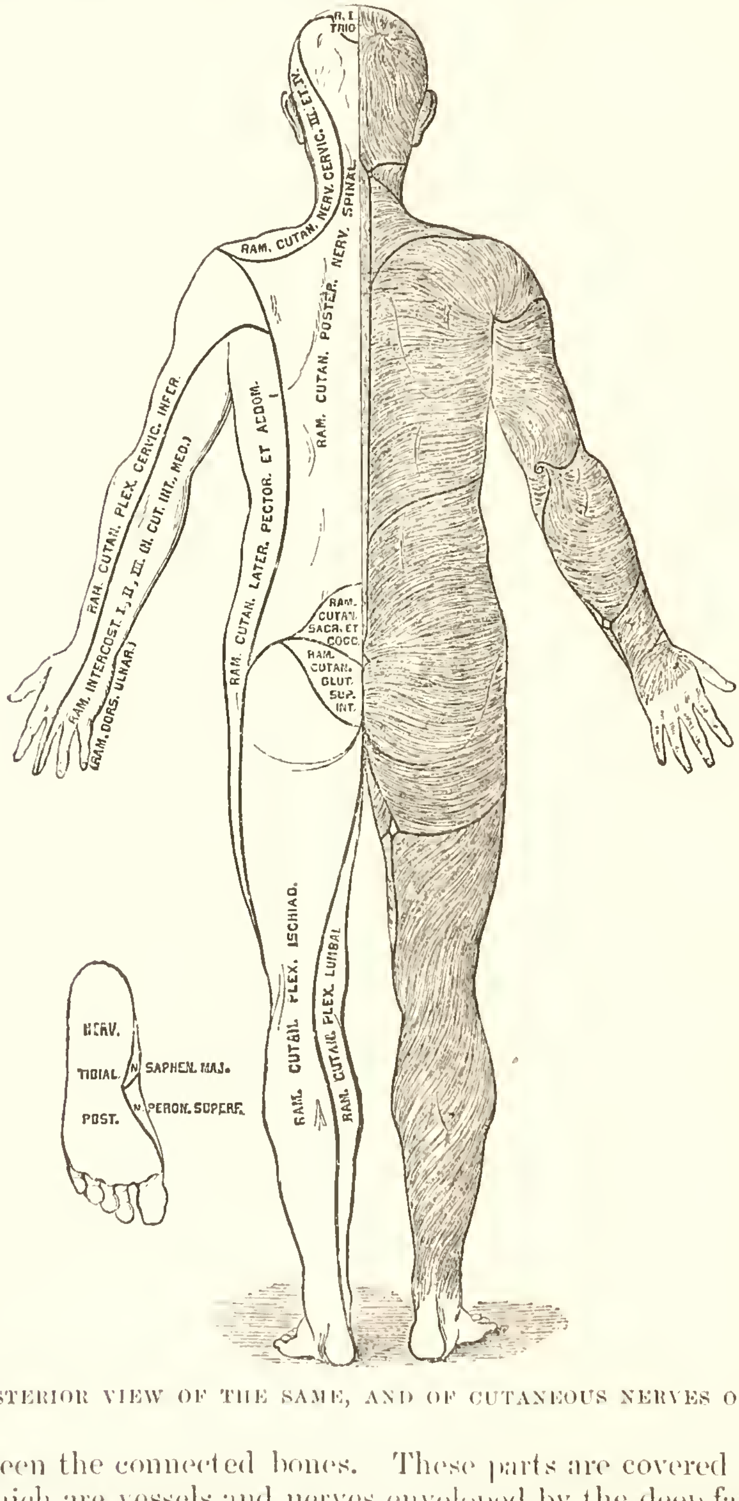


FIG. 3.—POSTERIOR VIEW OF THE SAME, AND OF CUTANEOUS NERVES OF THE SOLE.

joints between the connected bones. These parts are covered by muscles, between which are vessels and nerves enveloped by the deep fascia, around which are the superficial fascia or cellulo-fatty tissue, and the skin.

When the student is more advanced and possesses some practical, as

well as theoretical, knowledge of the morphology of man and the higher vertebrates, and of the processes of development and evolution, he will understand that the more correct division of the body would be simply into trunk and limbs. This being the better mode of description it will be here used.

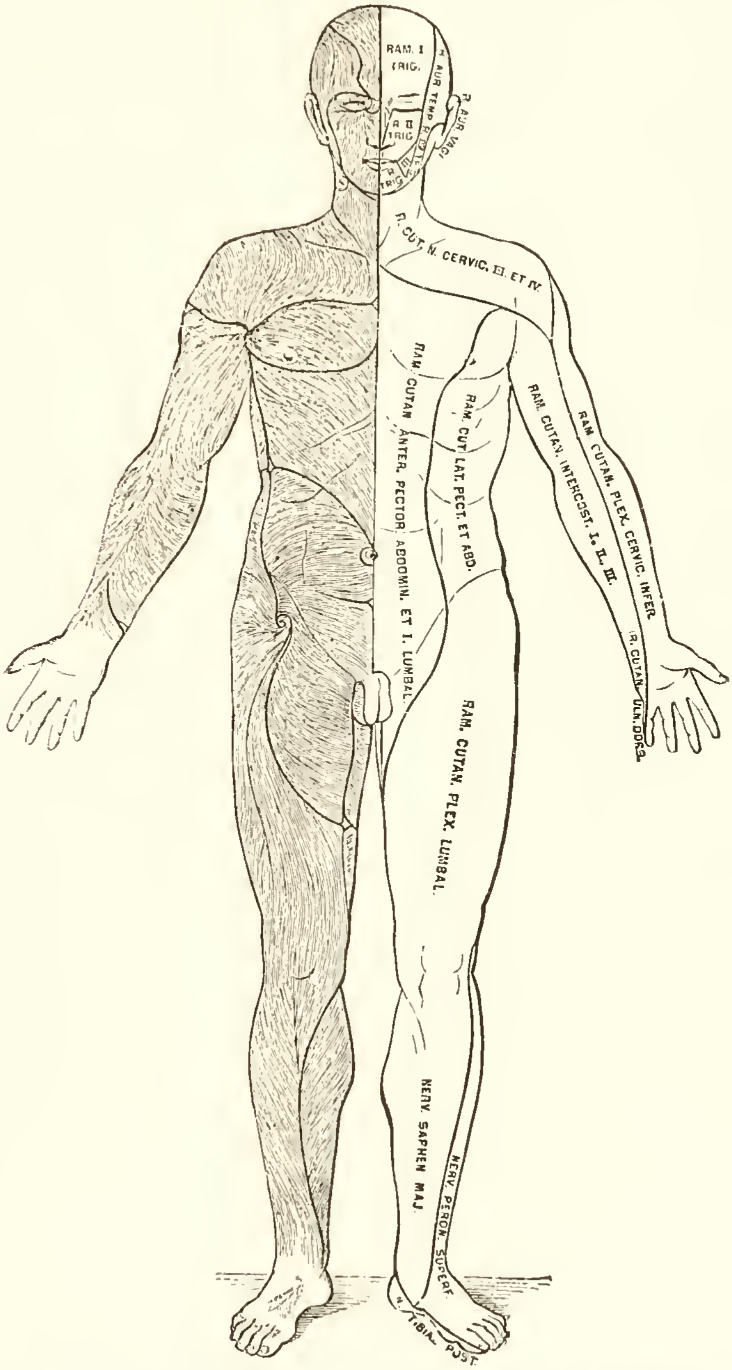


FIG. 4.—DIAGRAM OF THE DISTRIBUTION OF THE CUTANEOUS NERVES (ON THE LEFT OF BODY) AND OF THE HAIRS (ON THE RIGHT).

The **Trunk.**—The trunk is divisible into head, neck, and trunk or *torso*, properly so called.

The **Head.**—This comprises the cranium and face. In height it mea-

sures nearly the eighth of the total height of the body. It is smaller in the female, and varies in shape, weight, and volume in different individuals and in various races. Disease and anomalies in its development also produce variations in its shape and size. When development has been arrested there is the condition called *micro-cephalic*, which is almost always associated with deficient intellect; and when too much serum has

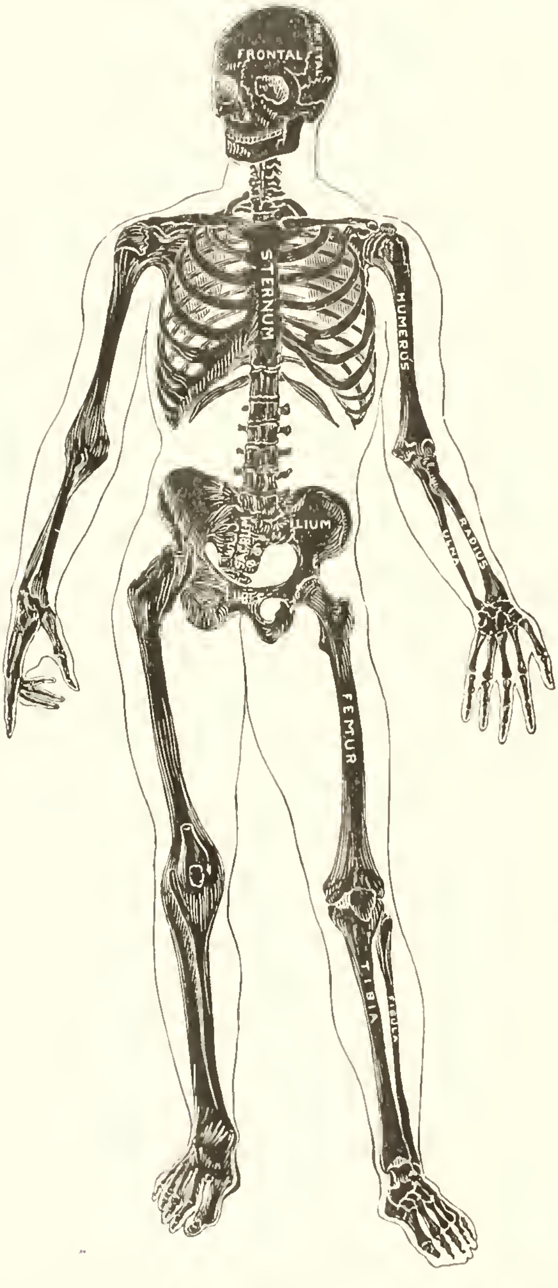


FIG. 5.—DIAGRAM TO SHOW THE RELATION OF THE BONES AND JOINTS TO THE SKIN. ANTERIOR VIEW. MALE.

been thrown out within the brain-membranes, or ventricles, *hydro-cephalic* skulls are produced. The relations between the volumes of the skull and of the face are subject to variation, and there even seems to be a sort of antagonism between these parts, which is observable in man, and more so in the lower animals. The skull has been divided into five equal parts

by four transverse lines passing: 1, between the two dental arches; 2, on a level with the floor of the orbit or malar prominences; 3, on a level with the upper margins of the orbits; and 4, through the frontal eminences; but this division is not adopted in anatomical works.

The **Skull.**—This has an ovoid form, and its greatest extent is in the antero-posterior direction, from the occiput to the lower border of the

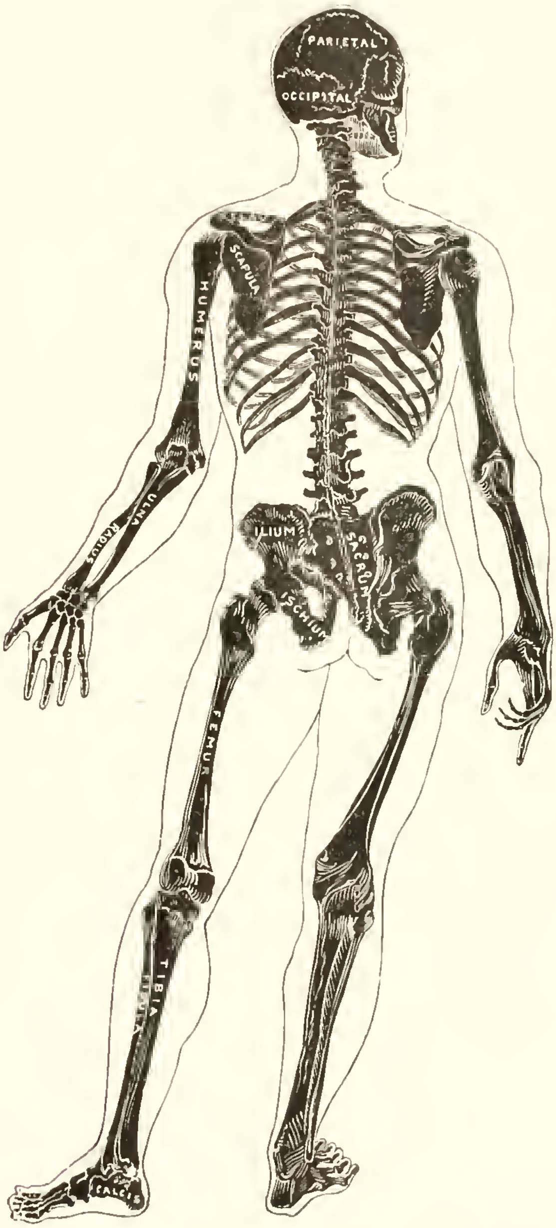


Fig. 6.—Diagram to show the relation of the bones to the skin. Posterior view. Male.

frontal bone. This ovoid is more or less compressed laterally, hence the distinction into *brachy-cephalic* and *dolicho-cephalic* skulls. The summit or vertex of the skull is more or less prominent, and in certain races or individuals may be raised into the form of a cone. This has been produced artificially in certain Tartar tribes. The cranium is divisible into

five regions: 1, the frontal or sinciput; 2, the occiput; 3, the temporal; 4, the vertex; and 5, the auricular or mastoid region.

The *frontal region* is prominent, straight, or retreating, and more or less high in different individuals. At the middle line it presents a vertical depression, which ends below in a prominence above the root of the nose, called the *glabella*; and above, it ends in the median frontal eminence, when it exists. At its sides are the lateral frontal eminences, which are separated by a transverse groove from the *supra-orbital ridges*.

The **Occiput** is rounded, passing laterally into the auricular regions, and at the middle line below is a prominence, which is the *occipital protuberance*, whose size varies in different individuals and is well covered with hairs.

The **Temporal** or *temporo-parietal* region corresponds to the temporal fossa and temporal muscle. It is slightly compressed below and in front, where it is clearly defined from the frontal region. It is convex in the rest of its extent, and is continuous above with the opposite temporal, and behind with the auricular region.

The **Vertex.**—This prominence corresponds with the meeting of the occipital and parietal bones. It is more prominent in some individuals than in others, and in common with the temporal and occipital regions is covered with hairs.

The **Auricular** or **Mastoid region** is situated behind the external ear, is prominent, and corresponds to the mastoid portion of the temporal bone. It is continuous in front with the temporal region, and behind with the occipital, and is devoid of hair.

The skull contains the cerebrum and cerebellum, and the cranial nerves pass through its foramina.

The **Face** comprehends, laterally, the *auricular* region, the cheeks or *malar* regions, and the *parotid* regions; and, in the middle line, the *nasal*, *buccal*, and *mental* regions, which will be described in the dissection of the head and neck. In the face are situated the organs of special sense—i.e. the eye, ear, nose, tongue—and also the mouth.

The **Neck.**—This is divisible into, 1, anterior region; 2, posterior or *nuchal* region; and 3, two lateral regions; and its length in the upright position of the head measures, from the chin to the middle of the inter-clavicular notch, about a quarter of the length of the trunk. It may be long as when the shoulders and upper ribs are sloping, or it may be short and impacted, as it were, between the shoulders. Its circumference and volume are variable, and in women it may increase in size during menstruation and pregnancy, in consequence of the greater size of the thyroid body at those periods. In man it has the form of a triangle whose angles are rounded in consequence of the prominence of the thyroid cartilage and of the sterno-mastoid muscles, but in women it is nearly cylindrical and more slender, and in the sub-hyoid origin often has a transverse fold called the *Collar of Venus*. The various sub-regions will be given with the surface markings in the dissection of the neck. In the neck are situated the windpipe, or *larynx*, the *œsophagus*, or gullet, the *thyroid* body, the carotid arteries, jugular veins and lymphatics; and at its upper part, beneath the lower jaw, are the *submaxillary* salivary glands. The cervical spinal nerves and the pneumogastric and sympathetic run through the neck.

The **Trunk** is composed of three parts—the thorax, abdomen, and pelvis.

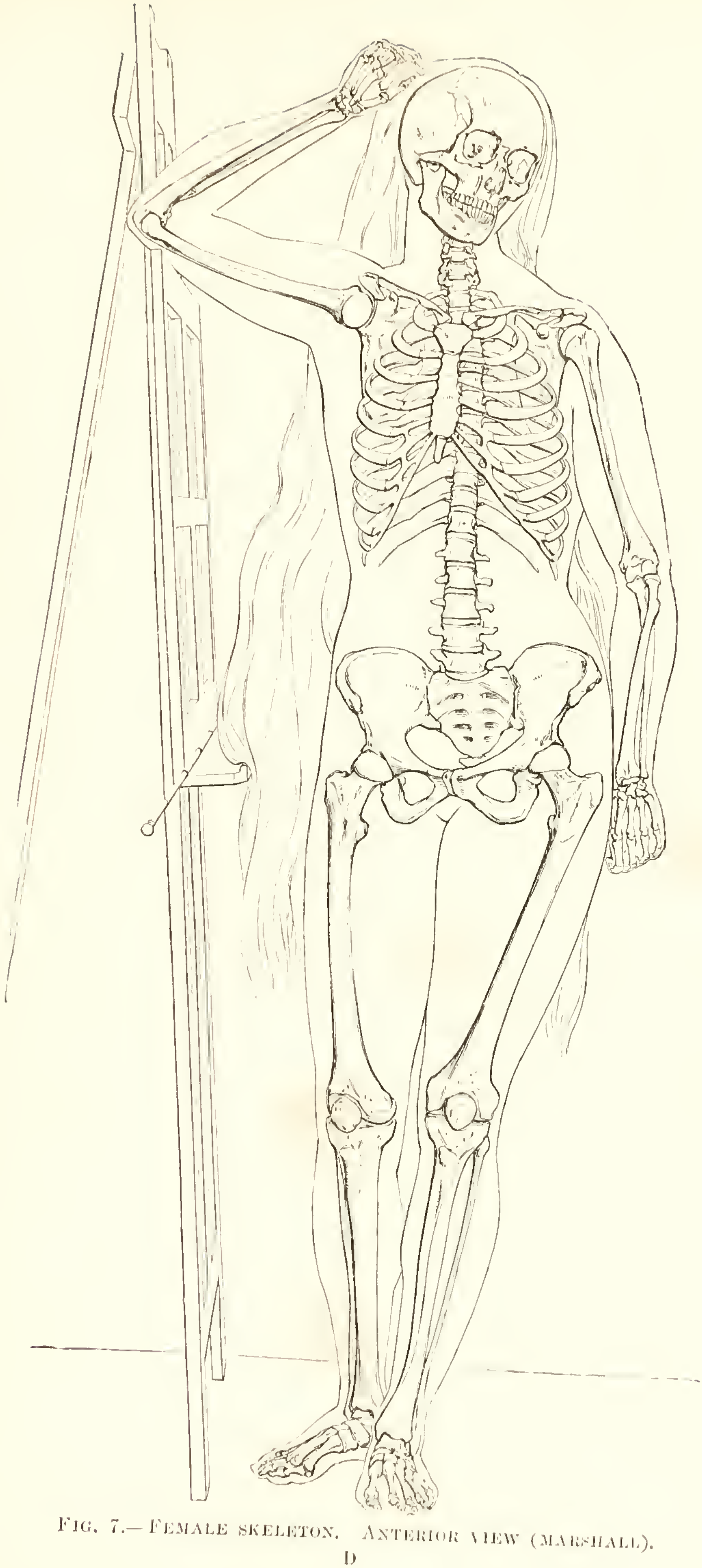
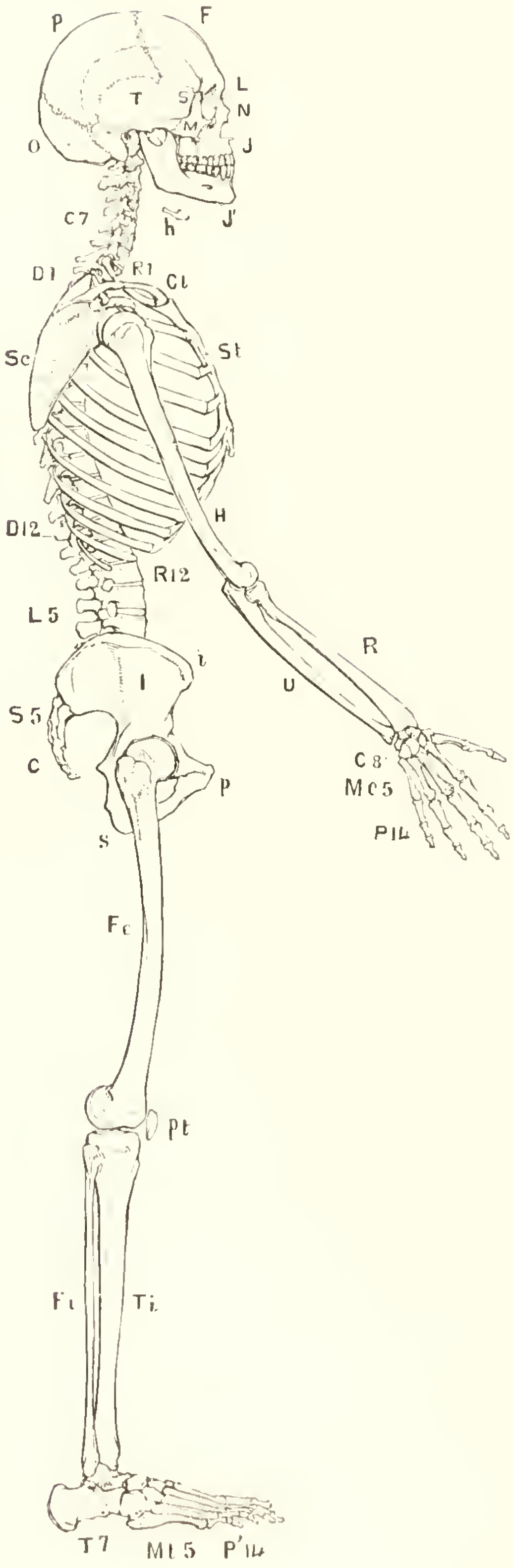


Fig. 7.—Female skeleton. Anterior view (Marshall).

D



F. Frontal.
P. Parietal.
O. Occipital.
T. Temporal.
S. Sphenoid.
L. Lachrymal.
N. Nasal.
J. Superior maxillary.
S. Symphysis of mandible.
M. Malar.
h. Hyoid.
C 7. The seven cervical vertebræ.
D 1–12. The twelve dorsal vertebræ.
L 5. The five lumbar vertebræ.
S 5. The five sacral vertebræ.
C. Coccyx.
Sc. Scapula.
R 1–12. First to twelfth rib.
Cl. Clavicle.
St. Sternum.
H. Humerus.
R. Radius.
U. Ulnar.
C 8. Carpal bones.
Mc 5. Metacarpals.
P 14. Phalanges.
I. Ilium.
i. Its ant. sup. spine.
p. Pubis.
S. Ischium.
Fe. Femur.
pt. Patella.
Ti. Tibia.
Fi. Fibula.
T 7. Tarsal bones.
Mt 5. Metatarsals.
P 14. Phalanges.

FIG. 8.—KEY-FIGURE OF THE SKELETON, SHOWING THE LIMBS OF THE RIGHT SIDE ONLY (MARSHALL).

The **Thorax** has the form of a quadrangular pyramid whose base is above and is compressed from before backwards. This shape is just the opposite to that of the bony framework of the thorax, and is due to the presence of the scapulæ and of the soft parts. The right side of the chest is usually larger than the left, and its axis is not ordinarily in a right line with that of the abdomen; i.e. a line passing from the inter-clavicular fossa to the middle of the xiphoid appendix makes, with another line

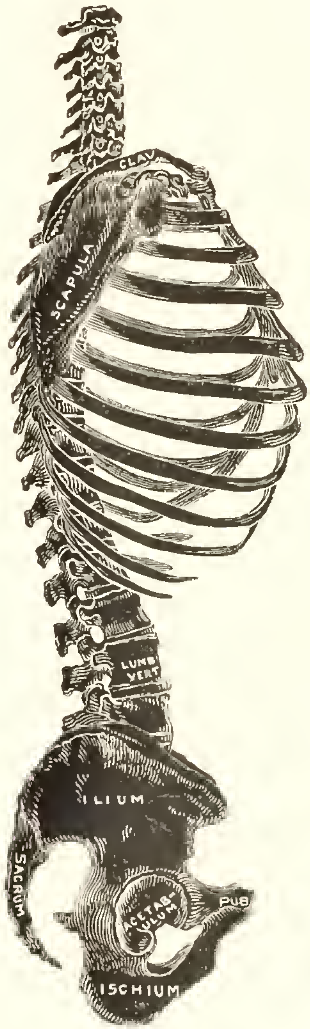


FIG. 9.—RIGHT-SIDE VIEW OF THE SPINAL COLUMN, RIBS, AND PELVIS.

passing from this appendix to the pubic symphysis, an obtuse angle open to the right. Independently of the size of the mammæ, the sexual differences are well marked in women, and the thoracic diameters, but chiefly the transverse diameters, are less than in men. The maximum antero-posterior diameter, instead of corresponding to the base of the xiphoid appendix, is at the middle of the sternum, which presents an anterior curvature. It has, besides, a more vertical position than in man, and thus the feminine chest possesses a more rounded form. The thorax is divisible into an anterior, posterior, and two lateral regions, which will be described with the dissection of this part; and it contains the heart, aorta, and other

large blood-vessels, the lungs, bronchi, the continuation of the œsophagus, and part of the thoracic duct.

The **Abdomen**, or *belly*, is situated between the lower boundary of the thorax and the upper limit of the thighs, in front, and the buttocks behind. Its deeper boundaries will be given with its dissection. It is larger behind and in front than laterally over the ribs, where its height

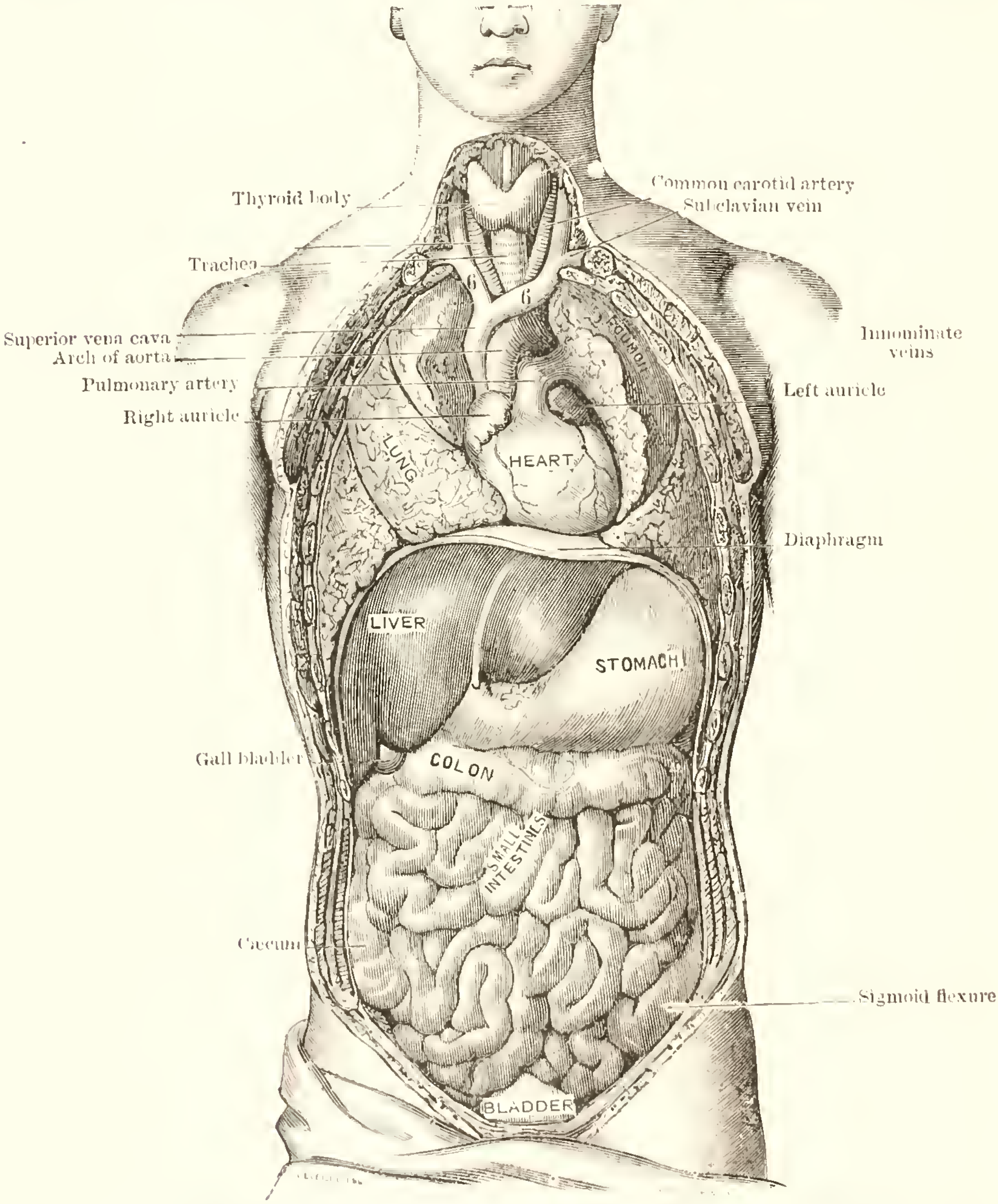
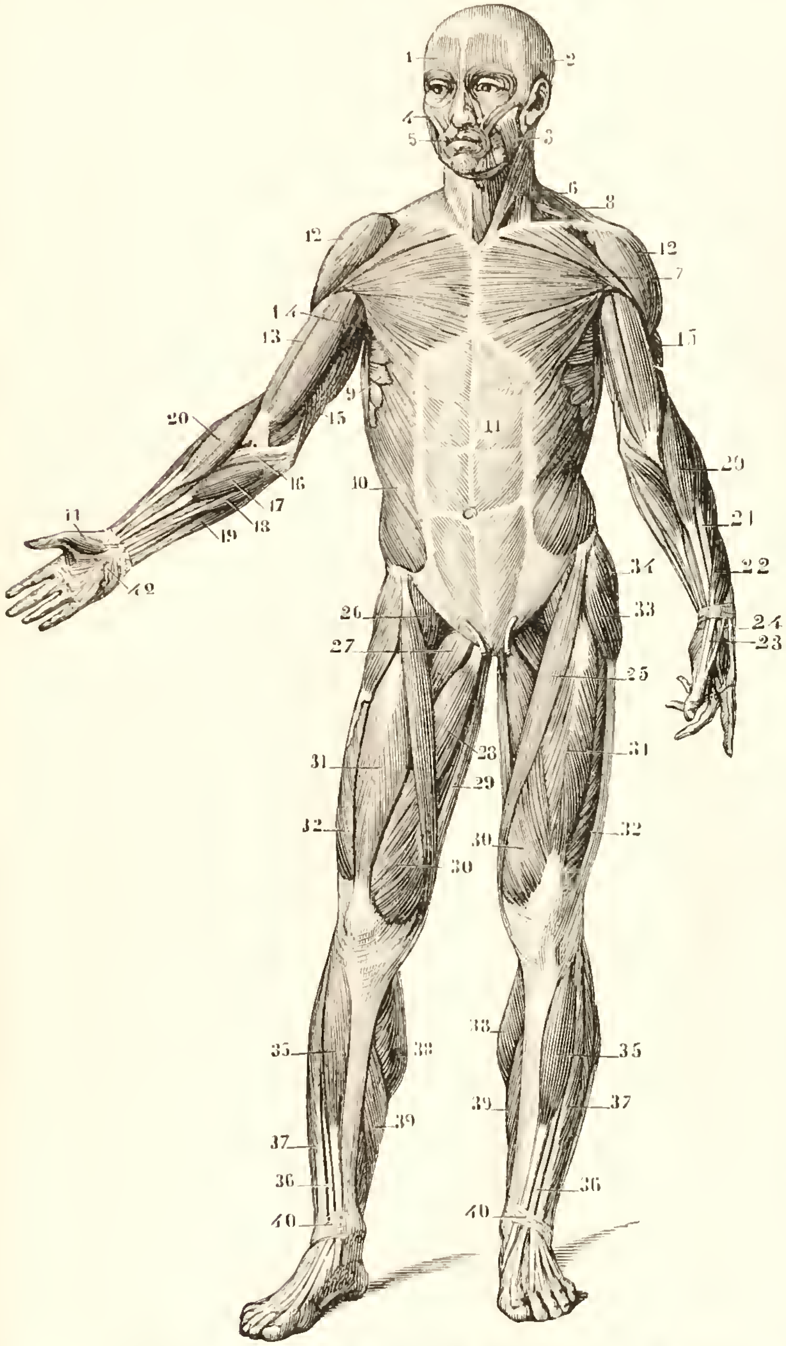


FIG. 10.—CONTENTS OF ABDOMEN AND THORAX. SUPERFICIAL ANTERIOR VIEW.

The figures 6 and 6 are placed on the innominate veins.

is measured by the distance between the twelfth rib and the iliac crests. This interval is larger in women than in men. The abdomen presents some noticeable sexual differences. It is longer and more projecting in front in women and larger below than above. In pregnancy in women, and in obesity in both sexes, as well as in abdominal and pelvic tumours, considerable modifications are produced in the size, shape, and consistence of

the abdominal wall. It is divisible into an anterior part or abdomen proper, a posterior or *lumbar* region and two lateral regions or flanks, and has been artificially divided by certain arbitrary lines for the convenience of the description of its contents. These will be given when the abdomen is dissected. In the abdomen are contained the stomach, small and large



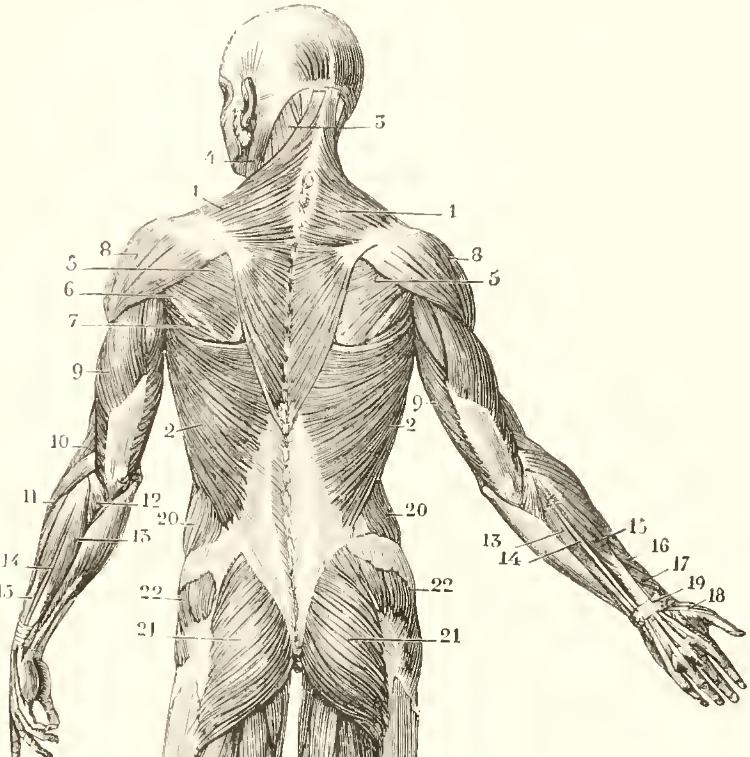
1. Frontalis.
2. Superior auricular.
3. Masseter.
4. Zygomaticus.
5. Orbicularis oris.
6. Sterno-mastoid.
7. Pectoralis major.
8. Trapezius.
9. Latissimus dorsi.
10. External oblique.
11. Rectus.
12. Deltoid.
13. Brachialis anticus.
14. Biceps.
15. Triceps.
16. Pronator teres.
17. Flexor carpi radialis.
18. Palmaris longus.
19. Flexor carpi ulnaris.
20. Supinator longus.
21. Extensor carpi radialis longior.
22. Extensor ossis metacarpi pollicis.
23. Extensor primi internodii pollicis.
24. Extensor indicis.
25. Sartorius.
26. Ilio psoas.
27. Pectineus.
28. Adductor longus.
29. Gracilis.
30. Vastus internus.
31. Rectus femoris.
32. Vastus externus.
33. Gluteus medius.
34. Tensor fasciae femoris.
35. Tibialis anticus.
36. Extensor proprius pollicis.
37. Extensor communis digitorum.
38. Gastrocnemius.
39. Soleus.
40. Anterior annular ligament.
41. Thenar eminence.
42. Hypothenar eminences.

FIG. 11.—DIAGRAM OF THE SUPERFICIAL MUSCLES. FRONT VIEW.

intestines, liver, spleen, pancreas, kidneys, supra-renal capsules, thoracic duct, abdominal aorta and its branches, the portal vein and its radicles, and the inferior vena cava and its tributaries.

Pelvis.—The external markings of the pelvis are not very distinct, but certain important sexual differences are recognisable. In women it is

larger, more voluminous, and above the great trochanters it is abruptly rounded and is continuous with the lateral walls of the abdomen, whilst below the trochanters it is gradually lost in the curve of the thigh. In certain races its inclination is very great. It is divisible into five regions: 1. An anterior or *pubic* region. 2. A posterior or *gluteal* region, which in



1. Trapezius.
2. Latissimus dorsi.
3. Splenius.
4. Sterno-mastoid.
5. Infra-spinatus.
6. Teres minor.
7. Teres major.
8. Deltoid.
9. Triceps.
10. Supinator longus.
11. Extensor carpi radialis longior.
12. Anconeus.
13. Extensor carpi ulnaris.
14. Extensor minimi digiti.
15. Extensor communis digitorum.
16. Extensor ossis metacarpi pollicis.
17. Extensor primi internodii pollicis.
18. Exten or secundi internodii pollicis.
19. Posterior annular ligament.
20. External oblique.
21. Gluteus maximus.
22. Gluteus medius.
23. Biceps.
24. Semi tendinosus.
25. Semi-membranosus.
26. Gracilis.
27 and 28. Gastrocnemius.
29. Soleus.
30. Peroneus longus.
31. Peroneus brevis.

FIG. 12. DIAGRAM OF THE SUPERFICIAL MUSCLES. POSTERIOR VIEW.

the female Hottentots acquires a very great size by the accumulation of fat over the gluteus maximus after the first pregnancy. This is by them regarded as a great sign of beauty. It is constant in various degrees in the Boschimans or Bushmen. 3. The lateral regions, *coxæ*, or hips. 4. The inferior or *perinæal* region; and 5, the groin or *ilio-inguinal* region,

which merges above in the abdominal wall and below into the thighs. The surface-markings of these regions will be described with their dissection. Within the pelvis are the bladder, rectum, iliac arteries and internal organs of generation in the female, and attached to the pubes are the external genitals of both sexes.

Limbs.—The upper and lower members are composed of an equal number of segments, and are subdivided into an equal number of secondary regions which correspond in the upper and lower limbs; e.g. the arm with the thigh, the forearm and leg, shoulder-joint and hip-joint, elbow and knee, wrist and ankle, and the hand and foot. The limb segments only

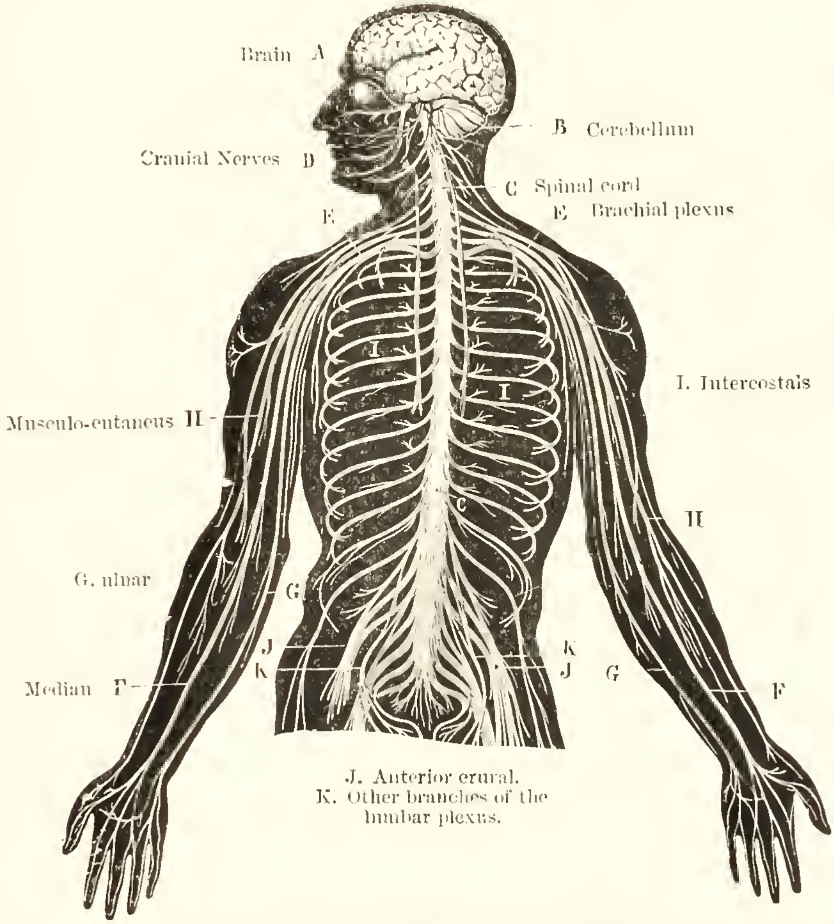


FIG. 13.—DIAGRAM OF NERVOUS SYSTEM OF THE UPPER HALF OF THE BODY. ANTERIOR VIEW.

The nerves of the lower limbs are omitted, but the lumbar plexus is shown. The pneumogastrics are seen running down near the sides of the cord.

change in form during muscular contraction, but the joints are of course susceptible of motion, and change their outward form in the various movements of the limbs. Mobility is the great characteristic of the upper or *thoracic* member; and strength for the support of the body and for locomotion is the characteristic of the lower or *abdominal* member.

The **Upper** or **Anterior Extremity.**—When this is hanging free by the side of the body with the fingers extended, it reaches to the junction of the middle and lower third of the thigh, and in this position the hand is between pronation and supination. The upper limb is divisible into the following secondary regions: shoulder, axilla, arm, elbow, forearm, wrist,

and hand with the fingers. These will be described in a subsequent part of the work, but it may here be mentioned that the forearm is longer in men, that the hand equals in length a fourth of the whole length of the upper limb, and also is said to equal the distance between the ends of the upper incisors and the vertex of the skull, also the distance from the occipital protuberance to the root of the nose, the distance from the inter-clavicular notch to the acromion, and is the third of the length of the spine, the sacrum not being included. It appears thus to be a true unit for the measure of the human body. It is irregularly quadrangular and its form varies in individuals, but may be reduced to two fundamental types: 1, the masculine, in which the transverse diameters preponderate; and 2, the feminine type, in which all the measurements are smaller.

Lower Extremity.—Its length is about one-fifth greater than that of the upper, and it is proportionately smaller in women. It is divisible into the hip, thigh, knee, leg, ankle, and foot with the toes, the surface markings of which will be given in the dissection of these regions.

Proportionate Weight of the Body-parts.—A great number of circumstances modify the development of the human body, such as hereditary influences, climate, food, hygienic surroundings, exercise, regimen, &c., and the result of these various influences is patent to the observant eye at any hour of the day. Several attempts have been made to reduce these variations into definite laws, and for the numerous observations which have from time to time been made to ascertain the average stature, weight, and capacity in European countries, the student, should he be interested in anthropology, or in medico-legal subjects, must refer to the works of Quetelet, Tenon, Riecke, Krause, Hoffmann, Liebig and Bischoff, and Roberts on Anthropometry; but it may be of use to the student to give, in this connection, Krause's recent table. The measurements are expressed in fractions of a metre, the average height of man being estimated at 1·67 metre.

	Man m.	Woman m.
Height of the body	1·737	1·629
From the vertex to the end of the coccyx	0·875	0·848
,, ,, ,, umbilicus	0·692	0·651

Head.

Height of the head, anterior part	0·217	0·203
,, ,, posterior ,,	0·142	0·135
Length of the head from occiput to front	0·203	0·190
Breadth of cranium, temporal diameter	0·142	0·128
Horizontal perimeter of cranium	0·610	0·570
Height of face from root of nose to chin	0·116	0·101
Size at the level of the molars	0·116	0·101
Breadth in front of the ears	0·149	0·116
Depth from the point of the nose to the ear	0·108	0·108

Neck.

Height of the anterior part	0·108	0·101
,, posterior ,,	0·116	0·108
Breadth of neck	0·118	0·101
Depth ,,	0·108	0·101
Circumference of neck	0·339	0·325

Thorax.

	Man m.	Woman m.
Height of sternal region	0·109	0·176
„ lateral parts	0·352	0·319
Breadth between the shoulders.	0·420	0·346
„ on a level with the axilla	0·257	0·237
Height of the posterior part	0·298	0·298
Breadth of the back with the shoulders . . .	0·339	0·319

Abdomen.

Height of the anterior wall	0·312	0·339
Distance from the epigastrium to the umbilicus .	0·176	0·179
„ „ umbilicus to the pubis . . .	0·135	0·162

Upper Limb.

Length of arm	0·325	0·298
Breadth „	0·095	0·088
Thickness „	0·088	0·081
Circumference of arm	0·285	0·257
Length of forearm	0·271	0·244
Its thickness at the upper end	0·081	0·074
Its circumference	0·271	0·244
Its thickness at the lower end	0·054	0·047
Its circumference	0·190	0·176
Length of the hand	0·196	0·176
Breadth of the hand	0·108	0·095

Lower Limb.

Height of the hip	0·244	0·217
Length of the thigh from the groin to the knee .	0·475	0·400
Its upper circumference	0·515	0·488
„ lower „	0·339	0·319
Length of the leg from the knee to the ankle . .	0·488	0·414
Circumference of the calf	0·366	0·339
Length of the foot	0·257	0·230

Quetelet has found the following proportions to prevail for the different parts of the body, taking the total height to equal 1,000.

Total height of body	1000
Head	135
From vertex to supra-orbital arch	59
From clavicle to nipple	105
Distance between the nipples	116
From vertex to clavicle	172
Distance between axilla	176
Diameter through the upper parts of the axilla	176
Diameter of the hand	53
Diameter of the forearm	37
Distance from the umbilicus to the patella	318
„ „ patella to the sole	280
Height of the malleolar	51
Distance from the perinæum to the sole	475
Distance from the summit of the shoulder to the root of the hand	341
Length of the foot	154
Distance from the vertex to the base of the nose	96
Diameter of the foot above the toes.	57
Distance from the elbow to the root of the hand	145

The weight of man is, on the average, 63 kilogrammes, that of woman 54 kilogrammes. The weight of the head is about one-fourth, and that of the trunk one-third of the total body weight. The two upper limbs with the shoulders make about one-sixth of it, and the two lower limbs with the hips about three-sevenths of the entire weight.

CHAPTER III.

ANATOMICAL TECHNICS.

A COMPETENT anatomist needs nothing other than the unprepared subject before him, but it is usual to inject the arterial system, and otherwise prepare the body before the incipient anatomist dissects it. In this section, therefore, we will consider, 1, the methods of injecting the body; 2, the anatomical laboratory, or dissecting room, and its appliances; 3, the method of dissecting the various apparatuses, muscles, vessels, nerves, &c.; 4, the method of preserving anatomical dissections or sections; and 5, we will conclude with some hints to the student as to how he should study anatomy and how to make frozen sections.

The Preparation of the Subjects.—There are two objects which are sought to be attained before the body is brought into the dissecting room. The first is to prevent or retard decomposition; and the second is, to fill the blood-vessels or the arterial division of them, so as to enable the student to trace out the smaller branches and their anastomoses, and to avoid cutting them. If some conservative fluid were not injected through the body by means of the arterial system, decomposition and putrefaction would proceed apace, more especially in the hot weather. In summer, twenty-four hours will produce a change in the body, and in winter it takes from two days to a week, or even more, according to the degree of cold, to produce putrefaction, which is recognised by the greenish colour of the skin, by the raising of the epidermis, which is then easily removed, and by the peculiar odour that is given off at the putrefying points.

These preservative injections were largely used in *embalming*, and are ordinarily liquid. The materials which constitute them pass through the walls of the capillaries into the substance of the tissues, and soak into the various anatomical elements. For the study of the arteries another kind of injection, which consists of a solidifiable substance, is thrown into the arteries, after the conservative fluid has been injected into them. It is not my intention to enter into minute details upon the various preservative fluids and their relative merits, nor to go largely into the question of embalming. For the purposes of the student it will suffice to give the best means of preserving the cadaver during a certain time—say a month or six weeks—which should be ample for all practical purposes.

The body being cold, there is no great need to introduce a warm injection, and if the liquid be prepared it may be injected into any artery, and the whole arterial system filled, unless there be a firm clot in some large vessel which impedes the injection; but it is better to select a large vessel such as the femoral or carotid arteries, and if the body has been subjected to post-mortem examination it will be easy to inject the subject

through the aorta. For ordinary purposes a large syringe is sufficient, but should a greater pressure be required, one of the various apparatuses figured in text-books of practical histology may be used. In injecting the arteries and veins, a cannula (see fig. 14) is introduced into the artery which has been previously cut down upon and exposed. A suitable thread is applied around the vessel and the nozzle of the cannula to keep the latter in its place. The syringe is filled to the exclusion of air by the injecting fluid, and is then fitted to the cannula; the piston is then to be steadily and firmly depressed, and jerking to be avoided. This process is repeated until the injection has succeeded; i.e. when the feeling of resistance shows that no more of the injection mass can be introduced.

The previous injection of the disinfecting and preservative fluid will have cleansed the arterial system so as to render it more pervious to the injecting material, and the success of the injection will be known by seeing that the subcutaneous arteries, especially the temporal or frontal, are distended by the liquid and give to the finger the sensation of a vein full of blood; and if a small incision be made into the skin of any part of the body, some of the injecting mass will exude. After some hours the vessels appear to have emptied themselves, and the skin surface presents a peculiar colour which is known to the experienced. Two or three days after, one sees on the surface of the skin little saline crystals which are due to the crystallisation of the salt which almost always is contained in the injection. The formation of these crystals is indicative of a good injection, and gives promise of the subject being preserved for a long time, and this crystallisation shows itself primarily on the trunk. These saline crystals form more slowly on dissected parts of the body, and only show in proportion as the parts become dry. The muscles and other organs become covered with a thick saline layer at the same time that they become harder. These observations have special reference to the saline conservative injections.

As already stated, a clot may interfere with the injection, or atheroma, which is a diseased condition of the coats of the vessels, may give rise to extravasation of the injected fluid in consequence of the rupture of the vessels, which is due to their inability to withstand the pressure applied in the course of the injection.

PRESERVATIVE INJECTION MASSES.

1.	White sugar	1000 parts
	Salt	2000 „
	Nitrate of potash	500 „
	Water	7500 „

Mix and make a solution. This injection preserves the colour of the muscles and gives excellent results when the arterial system has been previously flushed with water.

2.	Water	10000 parts
	Alum	500 „
	Salt	250 „

Mix and make a solution.

3.	Water	8000 parts
	Chloride of zinc	1000 „

Mix and make a solution.

4. Water . . . . 8000 parts
Sulphate of iron . . . . 1000 „

Mix and make a solution.

5. Hyposulphite of soda . . . . . . q.s. } to make a saturated solution
Water . . . . q.s. }

6. A saturated solution of carbolic acid or thymol, or one of less strength, is also very serviceable.

The hyposulphite solution has the advantage of perfectly preserving the subjects without putrefaction for two or three months, and also dries the parts while preserving them; but it has the disadvantage, like all sulphites, of causing a free crystallisation of the salt on the surface of the preparations, and of blunting the scalpel.

7. White arsenic . . . . 1000 parts
Water or methylated spirit . . . . . 10000 „ (Franchina)

This solution is dear, and may cause local or general arsenical poisoning.

The solution of creasote has also been employed, but some object to its odour, especially as it has no great advantage over others already mentioned.

8. Commercial glycerine . . . . . . 1000 parts
Crystallised carbolic acid . . . . . . 4 „

Dissolve the crystals in the glycerine in a water bath, and preserve in well stoppered bottles.

This carbolised glycerine has the advantage of giving suppleness to the organs, but it does not preserve the parts for so long a time as the hyposulphate of soda solution. It does not affect the scalpel, but its odour is disagreeable to many people.[1]

9. Hydrate of chloral . . . . 500 grammes
Distilled water . . . . $2\frac{1}{2}$ litres
Glycerine . . . . $2\frac{1}{2}$ „

Mix.

The anti-fermentiscible properties of chloral render it one of the best conservative agents of the tissues. It acts either by combining with the albuminoid materials or simply by the action of contact. Chloral alone, in a solution of 10 per cent., acts powerfully upon the muscles, which it hardens and dries almost to pulverisation, but if glycerine be added, as in the above formula, the tissues become more supple; but if, after injection with this solution, the tissues are exposed to the air, they dry gradually, and in a few months become mummified.

10. Tincture of myrrh or powdered myrrh or aloes . 10 per cent.
Flour or milk of sulphur . . . . . . 30 „
Boracic acid, crystallised . . . . . 60 „
Water . . . . q.s. { to make a fluid that will run or flow well

This injection is, I believe, new, at any rate to modern anatomists, but has the inconvenience to some extent of interfering with the subsequent injection of solidifiable matter.

[1] Terebene and Sanitas, the new preparations, have also good preservative qualities, and may be tried either alone or mixed with glycerine and water.

11.	Glycerine	100 parts
	Carbolic acid	15–17 ,,
	Alcohol	11 ,,

Chromic acid in from 2 to 5 per cent. solution, and bichromate of potash in 5 to 7 per cent. solution, are good conservative injections; as also is Müller's fluid, which consists of:

12.	Bichromate of potash	2–2½ grammes
	Sulphate of soda	1 ,,
	Aq. destill.	100 ,,

The following are very good preservative injections, and number 14 may be injected as a hot mixture without previously warming the body. When this is desired to be done the mixture must be quite hot and fluid, and the injection should be done rapidly. After injection the body should be left for twenty-four hours at the ordinary temperature, and then the usual mixture of wax, tallow, oil, and turpentine, coloured with cinnabar or some other colouring matter, should be injected. About 15 pounds of the mixture will be sufficient for a body.

13.	Alcohol of 96 per cent.	q.s.	
	Corrosive sublimate to saturation		
14.	Carbolic acid	1 pound	
	Spirit	1 ,,	
	Glycerine	1 ,,	
	Water	17 ,,	(Stieda.)
15.	Sulphate of alum	6000 grammes	
	Arsenious acid	125 ,,	
	Aq. destill.	3000 ,,	
			(Gannal.)

If more arsenic be added the longer will the body be preserved.

Goadby's liquid, which is a good preservative, consists of:

16.	Sea-salt	140 grammes
	Alum	70 ,,
	Corrosive sublimate	0·3 ,,

Dissolved in 2½ kilogrammes of carefully filtrated boiling water.

Farrant's fluid is composed of:

White arsenic . . . . . 0·11 gramme

Dissolved in 3·5 grammes of boiling distilled water. When cool the solution is mixed with an equal weight of glycerine, and also with an equal weight of the best gum arabic.

Another good conservative fluid is composed of:

17.	Chloride of sodium	157·5 grammes
	Alum	75 ,,
	Corrosive sublimate	0·014 ,,
	Water	1680 ,,

Permanganate of potash, or Condy's fluid, chloride of lime or Burnett's fluid, and chloralum have all certain advantages, and some drawbacks. Salicylic acid, the sulpho-carbolates, thymol, nitrate of amyl, chlorozone, camphor, tannin, pyrogallic acid, iron alum, saturated solution of common salt, and sulphur make excellent additions to, or substitutes for, the

various antiseptic, disinfectant or deodorising materials given in the previous formulæ.

18. Wickerheimer's fluids for preserving animal and vegetable tissues.

1.	Potassa	36 grammes
	Salt	15 ,,
	Alum	60 ,,
	Dissolved in Aq.	3 litres

This solution must be heated to 50° Centigrade (122° Fahr.), and 9 grammes of salicylic acid added, together with 45 grammes of methylic alcohol and 250 grammes of glycerine. Sometimes 3 grammes of saltpetre are added, and its preserving power may be improved by increasing the alcohol to 20 grammes, the salicylic acid to 12 grammes, and glycerine to 450 grammes per litre of liquid. This will preserve subjects for about a month free from odour.

2. Dissolve in 3000 grammes of boiling water

100	,,	alum
25	,,	common salt
12	,,	saltpetre
60	,,	carbonate of potash
10	,,	arsenious acid

Cool and filter, and to every ten litres of the solution add 4 litres of glycerine and 1 litre of methylic alcohol.

The third formula has been improved by Messrs. Poetz and Hohr of Berlin, who make two kinds, one for injecting and one for macerating and immersing bodies.

		For injecting	For immersing
3.	Arsenious acid	16 grammes	12 grammes
	Sodium chloride	80 ,,	60 ,,
	Potassium sulphite	200 ,,	150 ,,
	,, nitrate	25 ,,	18 ,,
	,, carbonate	20 ,,	15 ,,
	Water	10 litres	10 litres
	Glycerine	4 ,,	4 ,,
	Wood-naphtha	$\frac{3}{4}$,,	$\frac{3}{4}$,,

These fluids may be injected into the vessels or the body, or part may be immersed and preserved in them. After being removed from the fluid and dried, the tissues retain their elasticity and the joints their flexibility. In skeletons thus prepared, the most complicated movements can be executed, such as those of the chest, larynx, and other parts concerned in the mechanism of breathing. Lungs thus prepared may, even after years, be inflated by means of bellows; they swell ten times their size in the collapsed state, the lobes become distinct, the brown colour changes gradually into red, and the whole organ appears as if taken from a fresh body. Sections of delicate tissues, morbid formations which have been removed by operation, will appear after months as if in a fresh state. Anatomical preparations that are to be preserved dry are immersed in the fluid from six to twelve days, according to their size, then taken out and dried in the open air. Hollow organs, such as lungs, bladder, intestines, &c., must be filled with the preserving fluid, then placed in a vessel containing the same liquid, and afterwards distended with air and dried. For embalming and for preserving the natural colour of organs or parts, they must be put immediately into the fluid and must not be dried. See 'Brit. Med. Jour.' ii. 560, 749; also vol. i.

The following mixture has recently been found useful at the Westminster Hospital:

Common white arsenic, 1 pound, dissolved in a quart of water with a piece of common washing soda the size of a walnut. Add half a gallon of brown glycerine and 1 pound of saltpetre to preserve the colour of the muscles. Inject through the aorta while the fluid is warm, and keep the syringe in motion.

19.	Carbolic acid	1 pound
	Arsenious acid	1 ,,
	Acetate of potash	2 ,,
	Glycerine	1 ,,
	Methylated spirit	1 gallon

This formula is used at the London College of Surgeons, and if diluted with sufficient spirit will be ample to inject three bodies and to preserve them for a very long time.

Fumigation of the body with some preservative material, combined with fumigation of the blood-vessels, i.e. the forcing into them of medicated vapours, has not yet had a sufficient trial, or even—so far as I am aware—any trial at all.

METHOD OF PREVENTING ANATOMICAL PREPARATIONS FROM DRYING OR PUTREFYING DURING DISSECTION.

It often happens that the parts being dissected either dry rapidly, putrefy, or become covered with the salt of the injecting material which becomes crystallised. This can be to some extent prevented by keeping the parts covered and wrapped, or bandaged with material which has been dipped in a strong salt solution, or in some preservative liquid such as carbolic acid, &c. But the solution of glycerine and carbolic acid has the property of impeding putrefaction, of diminishing the formation of crystals, and of preventing the drying of the dissected parts; and if the glycerine be of good quality the smell of the solution is less disagreeable.

Commercial glycerine	1000 grammes
Crystallised carbolic acid . . .	4 ,,

Dissolve the crystals in the glycerine in a water bath, and preserve in well stoppered bottles.

A clean brush should be used to spread this liquid every day over the preparation, and in two or three days it will be observed that the muscles retain their colour and suppleness, that the tendons are more supple than in the fresh condition and become nearly transparent, and that the injected vessels are soft, and the material injected into them does not break even in a very cold winter. This liquid has, however, the disadvantage of blackening the muscles after a certain time.

The following solution has similar properties to the carbolised glycerine:—

Hydrate of chloral	1 part
Glycerine	5 ,,
Distilled water	10 ,,

HYDROTOMY.

This name has been given to the method which consists in washing subjects, or parts of them, by passing a large quantity of water through the circulatory system. By this means the body is relieved of the blood which it contains, and putrefaction is much retarded. Now-a-days, hydrotomy is very rarely indeed employed, but it is of great value if one wish to preserve subjects for a certain time without having recourse to preservative injections; and if it be desired to make museum preparations, hydrotomy should be employed before a conservative injection is made use of.[1]

In the preparation of the viscera, which are so often loaded with blood *post mortem*, it is of great service, both prior to injecting their vessels and ducts, and more especially if the corrosive injections are intended to be employed.

I am not aware that the operation of hydrotomy has been employed during dissection, but it has occurred to me that it might prove of service in demonstrating the course of the collateral circulation, more especially in the limbs and in the outer parts of the head and neck.

The entire subject, or, more conveniently, a part of the body, may be hydrotomised.

COMPLETE OR ENTIRE HYDROTOMY.

A large vessel, such as the common carotid or femoral, must be opened; a glass injection tube or cannula must be inserted into the vessel in the direction of the artery, and must be carefully and firmly tied in. To the free end of the cannula an india-rubber tube is attached, the other end of this tube being fixed to the stop-cock tube of the injecting apparatus, the size of which will vary according to the amount of pressure required. Or the injection pressure may be obtained by means of a connection with the water pipes of the room in which the subject is prepared, provided sufficient pressure can be obtained. For partial injections, one of the various apparatuses described and figured in works on practical histology will be sufficient. The strength of the rubber tube, and of the ligatures fixing the tube into the artery, must be proportionate to the pressure of the water.

Another ligature must be placed on the vessel into which the tube has been introduced so as to prevent the escape of the water by the return flow, but it is necessary to make an opening in some part of the body, to permit of the escape of the blood before, or immediately on commencing, the injection. A good seat of selection, on account of there being no artery in the region, is the midline of the sternum, which should be divided with a small saw, and its two halves separated by a piece of wood driven in between them with some force. This permits the hand to be introduced into the thorax, the pericardium to be seized and opened, and a small incision to be made into the right ventricle. A largish glass tube open at both ends should be inserted into the ventricle; the other extremity of it should project through the opening in the chest. The subject should be placed either on its side or belly, leaving the outer end of

[1] Methylated spirit and water may be used if it be desired to obtain a preservative as well as cleansing effect.

the tube free; then, by turning the stop-cock, a small stream of water should be allowed to flow through the body for some hours, after which a larger stream should be set running; but care must be taken not to employ too forcible a stream, as the pressure of the water would either lacerate the capillaries of certain tissues or break the ligatures on the vessels.

It will be remarked after a little while that the venous blood flows from the tube in the heart. This lasts for several hours, sometimes for a whole day, and the operation should be continued until nothing but unstained water flows from the tube. During the operation, the cellular tissue of the subject becomes infiltrated and swells, especially that of the face and extremities, and the skin becomes very white. This infiltration soon disappears, but it is well to leave the tube which was placed in the heart *in situ* for several hours after the flow of water through the vessels has been stopped. The artificial œdema may be got rid of by making several acupunctures, or by small incisions through the skin and cellular tissue.

When the student understands the anatomy of the circulation, he will perceive that by this method the water penetrates the whole arterial system, including the left side of the heart and the pulmonary veins; and the pressure being continued, the water passes through the capillaries and forces the blood along and through the veins to the right side of the heart, where it has been pushed by two different routes: one, by the vena cava, which receives the pressure of the water coming from all parts of the body; and the other, by the pulmonary artery, which receives the pressure of the water which has passed through the pulmonary veins and through the left auricle and ventricle. Those parts which are situated above the point where the tube has been placed are washed out by means of the collateral anastomoses.

If the injection be too rapid it may happen that the aortic sigmoid valves will offer an invincible obstacle to the passage of the liquid, and in such a case the vessels of the lesser or *pulmonary* circulation (extending from the left auricle to the right ventricle) may remain gorged with blood.

PARTIAL HYDROTOMY.

If it be desired to wash out a part of the body or a viscus, the injecting tube must be placed in the principal artery or duct and the arterioles (in the case of injection of part of a viscus) must be secured so as to prevent the escape of the water. If a limb only is being washed out the blood may be allowed to escape through the femoral or axillary veins. By these means the blood escapes through the corresponding veins, which are left open, and the operation is usually a simple one.

INJECTION OF BLOOD-VESSELS.

To facilitate the study of the blood-vessels it is usual to inject the arterial system in order that the method of distribution and anastomoses of the smaller vessels may be made out. For this purpose different substances may be used, the best of which will be given in the following formulæ.

There are different kinds of injections, the *ordinary* ones being employed for the arteries and veins, and are *opaque*, unless it be intended to make microscopic sections, and then the vehicle is *transparent*. The transparent or fine injections are used in the study of the capillaries, but these vessels may also be injected with opaque materials.

Special injections are used in the methods of corrosion and maceration.

COMMON OR ORDINARY INJECTIONS.

Good injection masses should consist of materials which rapidly yield to a moderate heat and which become solid on cooling. They should not be too soft in warm weather, nor too brittle in winter—two inconveniences which belong to injection masses in which tallow is used.

It is better to dissolve the materials given in the following formulæ in the water bath, but if one be obliged to prepare them over a fire, or over a gas flame, the materials should be placed in an earthen vessel the interior of which is varnished or enamelled. The mixture should not be allowed to boil, and during heating should be constantly stirred with a metal or glass rod or clean piece of wood. These injections may be prepared just before being used, or may be allowed to cool and be used subsequently.

All the following formulæ are good, but the last is the most penetrating injection, and the fourth is the simplest and cheapest. The spermaceti may be left out from it :—

1.	Tallow	300	parts
	Burgundy pitch or resin	120	,,
	Olive oil	120	,,
	Essence of turpentine	60	,,

Dissolve in a water bath and keep for use.

2.	Tallow	600	,,
	White wax	400	,,
	Venetian turpentine	200	,,

Dissolve.

3.	Yellow wax	300	,,
	Tallow	720	,,
	Olive oil	180	,,

Dissolve.

4.	Tallow	1000	,,
	Yellow wax	30	,,
	Venetian turpentine	120	,,
	Spermaceti	120	,,

Dissolve.

5.	Spermaceti	120	,,
	White wax	60	,,
	Venetian turpentine	60	,,

Dissolve.

6.	Plaster of Paris (finest)	$\frac{1}{4}$	lb.
	Size	3	oz.
	Aqua, enough to make a thin solution.		

This injection sets in half an hour, and dissection can be at once commenced. Plaster injections should not be used if frozen sections are to be made, as they are too brittle.

7.	Tallow	600 parts
	Yellow wax	280 ,,
	Oil	160 ,,
	Cinnabar	100 ,,
	Essence of turpentine	30 ,,

This mass is less brittle and makes prettier injections if carmine be substituted for the cinnabar, but it is dear. (Auffret.)

These substances may be used by themselves or may be coloured by the addition of different colouring materials. A red is ordinarily used for the arteries, blue for the veins, and green for the canals or ducts. They are mostly powders, and ought not to be mixed with the injection mass until after the fusion and mixture of the substances which compose them.

Red Injections.

1. Cinnabar finely powdered . . . . 40 parts
2. Carmine . . . . 4 ,,

Blue Injections.

1. Prussian blue . . . . 55 ,,
2. Indigo . . . . 30 ,,

Yellow Injections.

1. Orpiment . . . . 45 ,,
2. Gum . . . . 30 ,,

Green Injections.

1. { Verdigris . . . . 75 ,,
Carbonate of lead . . . . . . 24 ,,
Gum . . . . 15 ,, }

Mix.

2. { Orpiment.
Prussian blue. }

A sufficient quantity of each to make a green powder.

Black Injection.

Ivory black . . . . . . 15 ,,

White Injection.

Carbonate of lead . . . . . 80 ,,

The various aniline dyes may also be used either in powders, crystals, or in a liquid condition, also madder or cochineal. The proportions given above are those which should be used for every 500 parts of the injection mass. The colouring matter is mixed in the mortar with a little oil, so as to form a thick paste, and when the mixture has become homogeneous a little more oil should be added. This coloured cream should be added by degrees to the injection mass. When the latter is melted and stirred briskly, before adding the colouring matter, the vessel containing the melted injection mass should be removed from the fire or bath, and the colouring matter immediately added.[1]

[1] For partial injections carmine is excellent, and should be mixed in a mortar with a little alcohol till a fine paste is formed, to which a little oil should be added, and then this mixture should be added to the injection mass. For large injections carmine and wax are too expensive.

The cinnabar powder, the indigo, the prussian blue, the yellow powders and the black and white injection powders should be mixed and added in the manner just described; but if carmine be used for the red injection, it is necessary to crush it beforehand with a little alcohol, and make a fine paste to which a little oil, and subsequently the injection mass, should be added.[1]

If the green injection No. 1 be employed, one must be careful not to put it in the hot mixture, as the injection materials will not mix with it but will float above it.

The oil colours in tubes of Rowney & Co., of Oxford Street, or Winsor and Newton, of Rathbone Place, mix well with the injection masses, and form good colouring materials. Chinese vermilion makes a good red injection. Orange-crome yellow makes a good yellow injection. Emerald green and verdigris are good for green injections. Nottingham or Cremnitz white is good for white injections, and a good blue can be made by mixing the Cremnitz white with prussian blue.

Injections may be made into the hollow membranous viscera or into bony cavities, so as to take casts of them. These are best taken with white wax, gelatine or paraffine. Plaster of Paris may also be used for this purpose.

The student may have opportunities of making warm injections in limbs or parts which have been removed in the operating theatre, and he will find instructions for executing them in his manuals of practical histology.

Injection of the Arteries.—This may be done by the aorta, the carotids, axillary or femoral arteries. In most dissecting rooms the femoral artery is the one selected for injecting the body. For ordinary dissecting-room purposes it is not necessary to hydrotomise the subject before throwing in the coloured injecting mass, but if it be desired to trace the minutest ramifications of the vessels, it is necessary that hydrotomy should previously be performed.

Choice of Subjects.—The best subjects are the bodies of thinnish people up to forty or forty-five years of age. Those that have succumbed to a chronic wasting malady are very favourable subjects, but stout bodies and the cadavers of old people are unfavourable, because the former decompose rapidly, and in the latter the arterial coats are degenerated, and having lost their elasticity, are apt to rupture under the pressure of the injection force.

Method of Injecting.—This may be done by the methods described in the section on hydrotomy or by the use of an injecting syringe. The cannula is introduced into the artery, tied into it, and the syringe being filled, its nozzle fits into the broad part of the cannula; the stopcock is turned so as to be in a line with the nozzle of the syringe, and the injection steadily pushed out. The cannulæ are of various sizes, and at the end which is put into the artery there is a groove, into which the ligature fixing the artery to the nozzle should fit.

In introducing the cannula care must be taken not to penetrate between the middle and external coats of the artery, and after it has been introduced, three threads should be passed beneath the vessel: one is to prevent the return of the injection, another is the middle one, and should be tightened directly after the cannula is fixed into the artery; its object is

to fix the arterial wall on the ridge of the tube; and the third is only tightened after the injection is completed, and serves to prevent the exit of the material which has been injected into the arteries.

The cannula being in place, the body should be put into a hot bath of a temperature of 33°, for from four to six hours, according to the time of year, and longer for a big corpse than for a small one. Six hours at least will be needed in the winter. From two to three hours is enough for a child. The cannula should be closed with a cork before the subject is placed in a bath; and the injection can be made under water, if it be desired to exclude the air and to distend the deeper vessels.[1]

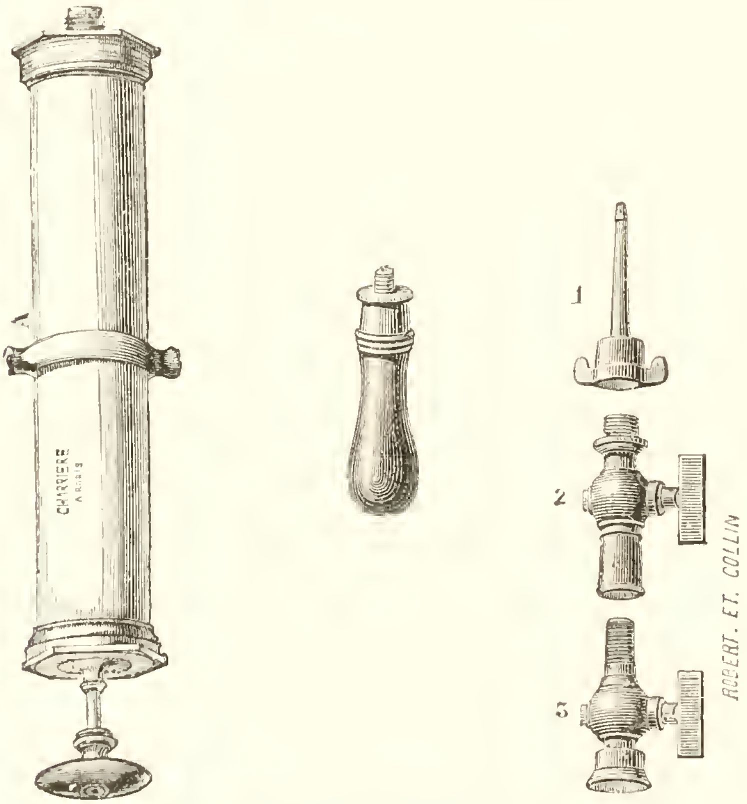


FIG. 11. INJECTION SYRINGE (reduced in size).

1. Cannula. 2 and 3. Stopcock tubes. To their left is a handle.

It is not necessary in warm weather to make use of a bath, as the body can be sufficiently injected for coarse anatomical purposes without this preliminary step.

There is a little intermediate apparatus, fitted with a stopcock, one end of which fits into the broad end of the cannula, and the other receives the nozzle of the syringe. The cannula and the stopcock tube should be kept warm during injection in cold weather, by placing a flannel wrung out of hot water around them, or by allowing hot water to drop on to the tube during the injection process, so as to prevent the coagulation of the solidifiable materials in the injection mass.

The injection mass having been prepared, and the syringe warmed, the stopcock should be placed parallel with the length of the syringe, and

[1] At the London College of Surgeons and at the University of Edinburgh the injection is not made under water.

the liquid slowly thrown into the vessels. The injection mass should not be too warm. A good test for ordinary practical purposes is, that the finger should just be able to support the temperature of the liquid. The syringe being filled, it should be held with the piston down and its nozzle upwards. The piston should be slowly pushed up until a little of the injection material runs out. The object of this proceeding is to exclude the air. Then the syringe should be quickly and cleverly fitted into the cannula, and the stopcock being turned in the proper direction, the injection is slowly and evenly thrown in. When the syringe is empty the stopcock is turned to a right angle, the syringe refilled, and the process repeated until a feeling of resistance is experienced. Four to six pounds of injection is sometimes necessary to completely fill the arterial system.

The injection is successful when the vessels of the skin are seen to assume a pinkish hue; then a quivering sensation is usually felt.

The piston of the syringe may be pushed home by the abdominal wall of the operator, but the force necessary in this, or in any other method, is proportionate to the calibre of the cannula, being greater with small cannulæ.

The injection being completed, the stopcock is turned to a right angle, the third ligature, which was placed beneath the vessel and left untied,

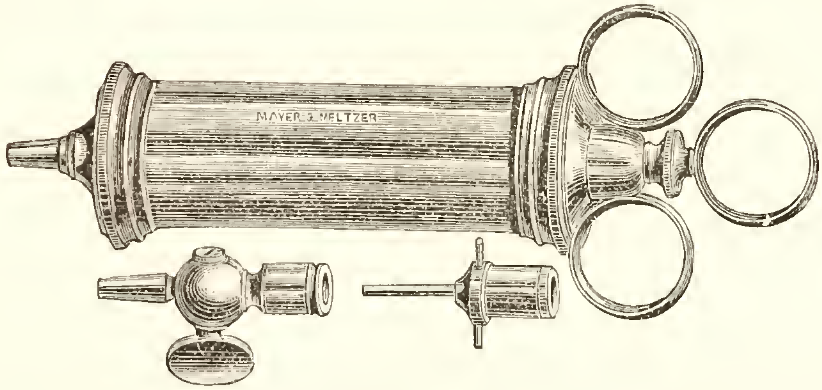


FIG. 15.—ANOTHER FORM OF INJECTION SYRINGE WITH STOP-COCK AND CANNULA.

must now be securely fastened to prevent the egress of the injection mass, the cannula should be withdrawn, and the coagulation of the injection and the fixing of the colouring matter may be hastened by replacing the warm water of the bath by cold or iced water.

Mechanical Injection Syringe.—By the use of the instrument figured below, all great muscular effort is avoided and regularity of action assured. It is equally serviceable for preservation or coloured injections, but must be kept thoroughly clean. The subject being put on its back, the empty apparatus is adapted to the cannula, which has been previously well fastened in the aorta (see fig. 16), or in the femoral or brachial. The syringe is then withdrawn, pivoted to one side, and the stopcocks turned towards the injector and fixed by strings to the bracket which supports the instrument. The injection matter is held by the left hand and presented to the nozzle of the syringe, which is then worked by the right, and when the syringe is full the threads are removed, the stopcocks turned off, and the syringe placed in the aortic cannula. The stopcocks are then opened and the injection thrown in. The left thumb and fingers steady the syringe and cannula during the injection, and should close both stop-

cocks simultaneously as soon as the subject has been sufficiently injected. This apparatus is made by Collins et Cie., Paris.

Injection of Veins.—These may also be complete or partial, and the bodies of old people are the most favourable, as in them the venous system is well developed.

To succeed in the injection of the veins, it is almost indispensable to perform a previous hydrotomy, otherwise there will always remain some blood in the veins, and the injection will not succeed.

To inject the entire venous system one must proceed in an opposite manner to that adopted for the arteries; for, if a big venous trunk be injected, the liquid will not reach the small veins because of the numerous valves which obstruct the flow of the latter.

The steps for preparing the injection, and tying in the cannula, &c., are the same as those just described, but it is necessary to have two

FIG. 16.—FARABEUF'S INJECTING APPARATUS IN POSITION AS USED IN THE PARIS FACULTY OF MEDICINE.

cannulæ for each foot and hand, in order to inject the venous system satisfactorily. The cannulæ must be of small caliber, and should be introduced into the veins on the inner and outer side of the dorsum of the hand, as well as into the cephalic vein of the thumb; and, on the dorsum of the foot, into the veins forming the venous arch, or into the external and internal saphena veins. By these means the whole venous system, with the exception of the portal vein, can be injected.

The steps of the injection and the ingredients of the injection mass have already been given, but the colouring matter for the veins is usually a blue one. As the vein walls are very thin, one must be careful not to pass the cannula between the outer and middle tunics, and the correct position of the instrument will be recognised by passing a fine wire along it.

The *portal vein* can be injected by opening the abdomen, turning aside the omentum and some small intestine, and introducing the cannula into one of the veins accompanying the branches of the superior mesenteric artery. The whole portal system may easily be injected, as there are no valves in these veins, and they do not communicate with other veins.

If the subject have been well injected the appearances will be those described under the head *Results of Operation* on p. 65.

PARTIAL INJECTIONS.

It is sometimes advantageous, in order to save the injecting material, to make only partial injections for the study of certain limited portions of the body; thus, the head and neck, the trunk, the limbs, or parts of these, may have their arteries, veins, or lymphatics injected, or even all of these if thought necessary.

Injection of the Head and Neck.—If only one side is desired to be injected it may be done through the lower part of the common carotid, or internal jugular vein. The veins of the head and neck being almost entirely devoid of valves, a good injection of these parts may be made against the ordinary course of the circulation which is towards the heart.

To inject both sides, the sternum must be raised from below, leaving it and the first rib adherent to the soft parts of the neck. The lungs must be separated and the aorta tied before it gives off the innominate artery, and also beyond the origin of the left subclavian. Then both subclavians should be tied in the subclavian triangles outside the scaleni, care being taken not to divide the transverse cervical artery, otherwise the injection will escape at the wound. It may be necessary to secure the bronchial arteries if they have been wounded. Should the vertebral artery be given off, as occasionally occurs, outside the scalenus, it must not be included in the ligature of the subclavian, which should be tied beyond it. It will be sufficient to inject through one carotid, as the free anastomoses of the vessels of opposite sides allow of the injection of the other side.

Injection of the Upper Limb.—The first part of the axillary artery just beyond the clavicle must be carefully opened, the cannula introduced and tied in, and half a pound of injecting material thrown into the arteries. If the veins be injected at the same time, or subsequently, the axillary vein should be tied through the same incision, and the superficial and deep veins of the limb will be filled by injecting from two of the small veins of the hand, as already indicated.

To inject the upper limb or any part of it after separation from the trunk, one simply has to tie a cannula into the end of the divided main artery, and to tie any collaterals through which the injection might escape. When the limb has been sufficiently injected, the vessels are tied, and coagulation accelerated by placing in cold water.

Injection of the Lower Limb.—This should be done through the external iliac artery, being careful in cutting down on that vessel not to wound the epigastric or circumflex iliac branches. If the injection flow freely and be thoroughly successful, these branches and their anastomoses with the internal mammary and lumbar, &c., will be distended.

To inject the veins of the lower limb two cannulæ should be introduced

into the veins on the dorsum of the foot, as already described, and the external iliac vein must be either tied or compressed against the ilio-pectineal line. If it be wished to inject the veins of the lower or upper limb after separation from the trunk, it will suffice to rub and press the limb forcibly from below upwards, so as to express the blood from the veins.

To inject the detached lower limb introduce the cannula into the main vessel, securing any collateral branches. The lower limb will require a pound, or perhaps more, of injection fluid.

Injection of the Trunk.—The veins and arteries of the contained viscera and of the trunk walls can only be thoroughly injected by a general injection. If it be desired to inject the trunk alone, the axillary, femoral, carotids and vertebrals must be tied.

Most of the veins of the trunk may be injected by the veins of the neck, as they are for the most part devoid of valves. The axillary and femoral veins should be tied and the cannula introduced into one of the jugulars, the internal being the better one to select. The opposite jugulars should be tied unless one wishes to inject the head and trunk at the same time, this being perfectly easy to be done if necessary; but for this simultaneous injection of the head and neck to succeed, a ligature must be placed above the point where the cannula has been introduced into the internal jugular so as to prevent the reflux exit of the injecting matter through the veins of the opposite side, as the venous anastomoses are free and often well developed in old people.

Injection of the Veins of the Head, Neck, and Spine.—It is impossible to inject the veins of the head and neck without at the same time injecting those of the spine in consequence of the free anastomoses between them. The steps of the operation are: 1, opening of the thorax and abdomen in the mid-line; 2, ligaturing of the two subclavian veins in the subclavian triangle; 3, ligaturing of the internal mammary veins; 4, ligaturing of the roots of the lungs, to prevent the injection passing into the bronchial veins; 5, ligaturing of the inferior vena cava between the heart and diaphragm; 6, ligaturing of both common iliac veins; and 7, introduction of a large cannula upwards into the superior vena cava just above its entrance into the right auricle.

The course taken by the injection is along the jugular to the sinuses of the dura mater, to the cerebral veins and the ophthalmic vein. It cannot pass into the upper limbs but goes along the superior intercostal veins and into the rachidian veins of the upper part of the spinal column. From the superior vena cava the injection passes into the azygos major, and secondly through the lower intercostals into the inferior rachidian veins, and as all the veins of the spine communicate largely, and are devoid of valves, the injection will distend them. The spinal veins communicate in the lumbar region with the lumbar veins which empty into the inferior vena cava. The injection passes into the inferior cava, which it fills, but in consequence of the common iliac veins and the inferior vena cava having been previously tied, it cannot extend in these directions, but the suprarenal and spermatic veins are injected.

If it be wished to inject the right side of the heart at the same time, the inferior vena cava should not be tied.

FINE INJECTIONS.

These are mostly used for histological purposes and may be opaque or transparent, and are generally used when both the body and the liquid are warm. Sometimes, when one wishes to inject the capillaries of a particular part or visens, one follows up the fine by an ordinary injection, so as to force the fine injection towards the capillaries.

The student will find formulæ and instructions in his books on practical histology, so that it is only necessary here to say a few words about them.

These injections are ordinarily used for anatomical purposes when they are of the consistence of cream. They do not remain liquid long, and after a short exposure to the air, or immersion for a short time in alcohol or ice, the parts may be divided without the injection escaping :—

1. White of egg diluted with half its weight of water to which a fine colouring matter has been added.

2. Spanish wax dissolved and coloured, and pure alcohol saturated with it. This should be preserved in a well stoppered bottle.

3. The finer oil colours used by painters, diluted in a little essence of turpentine.

Place the injected parts for three or four hours in alcohol to coagulate the injecting material.

If it be desired to inject the arteries, veins, lymphatics and ducts of a viseus, injections of different colours should be used: blue for the arteries; red for the portal, hepatic, or renal veins; white for the hepatic duct, ureter, or the ducts of other glands; and yellow for the veins, because if the ordinary blue be thrown into the veins, which are much more dilatable than arteries, the blue colour will mask the arterioles, which are very slender. The lymphatics may be injected with alkanna, quicksilver, fused metals, or with nitrate of silver.

Varnish and ink should not be used, as the former renders the preparation sticky, and the latter transudes through the coats of the vessels, unless these have been previously injected with a solution of tannin, or iron alum, or with chloral hydrate.

Coloured gelatine is largely used and is very serviceable, but it has some inconveniences, as it either breaks, or sometimes becomes too tough in drying, and if it be too liquid at the time of injection it transudes the vessel walls. Other vehicles are gum, paraffine, isinglass, glue (?), and some of the cements, but the majority of these are only serviceable for coarse injections. These injections are best done by water pressure as described at p. 56.

CORROSION INJECTIONS.

The vessels or canals of an organ or part may be injected by a material which is proof against certain liquids, and subsequently the injected part is placed in these liquids, which destroy by corrosion all the parts except the injected matter, which remains as a cast of the vessels and ducts. The brain, lungs, liver, placenta, spleen, kidney, and salivary glands are usually thus injected. If desired, the arteries, veins, and canals of an organ may be injected by corrosion injections of different colours.

The desiderata for a corrosion mass are that it should be proof against the liquid which destroys the substance of the organ, it should not be fragile, and it should be sufficiently strong and coherent to last as a durable preparation. It should contain little wax and no fat.

1.	Resin	200 parts
	Venetian turpentine	50 ,,

Dissolve in a moderate heat.

2.	Boiled Venetian turpentine . . .	240 parts
	Yellow wax	60 ,,

Dissolve in a moderate heat. The boiled turpentine is as resistant as the resin mass.

3.	Resin	90 parts
	White wax	30 ,,
	Venetian turpentine	30 ,,
	Spermaceti	15 ,,

Dissolve in a moderate heat.

HYRTL'S INJECTION MASS.

4. Wax and mastic varnish in the proportion of one of the latter to six of the former, mixed with some colouring material such as cinnabar, cobalt, chrome yellow, Cremnitz white, green, &c.

4a.	White wax Turpentine Copaiba	Equal parts (?) with some colouring matter added. See *Hyrtl's Corrosionsanatomie.*

HOYER'S CORROSION MASS.

5. A quantity of best shellac is placed in a wide-mouthed thin-bottomed flask and is just covered with alcohol of 80 per cent. After 24 hours, place the flask in a warm water bath to dissolve the shellac. When cool, add alcohol until the mixture is of the consistence of a thin syrup, then strain it through thick muslin. Add to a one-third of this mixture a concentrated and filtered alcoholic solution of Berlin blue, or aniline blue; to another one-third add a similar solution of cinnabar, and to the remaining one-third a similar solution of yellow sulphate of arsenic. A mixture of Berlin blue and sulphate of arsenic gives a beautiful green, and a permanent yellow may be obtained by adding freshly precipitated sulphate of cadmium. Any of the aniline dyes such as aniline red or violet, mauve, magenta or coralline, may be used instead of the above.

6.	Virginia wax	1 part
	Canada balsam	1 ,,
	Cinnabar	$\frac{1}{4}$,,

Instead of the cinnabar, a $\frac{1}{4}$ part of chrome yellow may be added to another bottle of the mixture, so as to have two coloured preparations.

Hoyer, to lessen the brittleness of this mass, adds a 5 per cent. alcoholic solution of Venetian turpentine which has been filtered through muslin or paper, and to harden the parts injected with this mass, he employs either pure chromic acid solution or a mixture of chromic or hydrochloric acids,

1 part of each to 250–500 parts of water. The parts, or sections, are then treated with concentrated glycerine.

Hoyer's mass, though less brittle than Hyrtl's, is also too fragile; and I would recommend the following formula to make a mass, which is much more tenacious:

White wax	1 part
Resin	5 „

A still more supple mass may be made thus:

Resin	5 parts
Ox tallow, suet, or lard . .	$1\frac{1}{2}$ „

These injections may be coloured by some of the materials already given, or 90 parts of vermilion, or 30 parts of Prussian blue may be added to 300 parts of the injection mass. The liquified injection should be filtered through lint to rid it of any impurities.

To inject the Lungs.—This may be done *in situ*, or after removal of the lungs, trachea, and heart; and the arteries, veins, and bronchi can then be injected.

To inject the Liver.—It and the diaphragm should be removed together, and the inferior vena cava above and below the liver should be tied. The injection should be made through the portal vein or hepatic artery, and bile duct if required.

To inject the Kidney.—This may be done *in situ*, or if after removal the capsular vessels and spermatic vein should be ligatured. Before injecting it any organ should be placed in a warm bath of a temperature of 33° for about two hours and injected under water, and after injection it should be put in the position desired, and allowed to cool. If this be not done at this stage, the injection will most likely break.[1]

The injection is more thorough if the organ have been thoroughly hydrotomised and subsequently injected with a preservative fluid. The injection of hydrate of chloral 10 in 100 gives good results, as it hardens the vascular walls.

The cooled organ should be placed in a glass or porcelain receptacle that has a hole in its bottom, which is closed by a glass or porcelain plug. A solution of two-thirds of nitric or hydrochloric acid to one-third water should be poured into the vessel until the viscus or part is covered.[2] In from three to four weeks the organic matter is reduced to an offensive pulp, and if the plug be removed from the bottom of the vase this and the acid will run away. If this maceration has not been sufficient, some more acid should be applied and left in contact with the organ for about two weeks; and when the organic matter is destroyed, a small stream of water is allowed to flow over the preparation to wash the surface of the injection-cast and to cleanse it of any small pieces which may be adherent. The preparation is then allowed to dry, and subsequently coated with varnish, which is gently poured over it to give it a shining aspect. Any

[1] If the organ be isolated before injection, it is best to wash it well out, both internally and externally, then to squeeze out the water and hang it up to allow the water to drain off. It should then be placed in Le Prieur's or some other suitable preservative fluid for half an hour before proceeding with the other steps.

[2] It is better at first to place the preparation in equal parts of the acid and water, and gradually strengthen.

excess of varnish may be carefully removed with a brush, and if it be desired to deepen or alter the colouring, one or two coats of oil paint may be applied before the varnish is put on.

MACERATION INJECTIONS

These are little employed. Molten metals or mixtures, or alloys of them, are used. They have been chiefly employed to inject the bronchi or lymphatics.

Bismuth	8 parts
Tin	4 ,,
Lead	4 ,,

If a small quantity of quicksilver be added it will bring this mixture to a lower melting point.

Hyrtl recommends a mixture of:

Bismuth	2 parts
Lead	1 ,,
Tin	1 ,,

Another preparation is:

Bismuth	40 ,,
Lead	45 ,,
Tin	15 ,,

These molten metals are poured into the vessels through funnels, and the formation of air bladders carefully guarded against. The injected parts should be exposed to the air in open vessels and in the direct sunlight for a varying time—one, two, or three months—until the soft parts have been destroyed by putrefaction. They are then washed away and the metallic cast preserved.

INJECTION OF THE LYMPHATICS.

These are more easily injected in a thin body and one which is œdematous, but if it be desired to inject the cutaneous lymphatics, it is better to select a subject in which putrefaction has commenced, and in which the epidermis can be separated from the dermis.

Mascagni's method consisted in injecting the blood-vessels with coloured gelatine, which in time partly exuded from them and was taken up by the lymphatics, which thus became coloured. Fohmann and Panizza injected mercury by penetrating the skin and subcutaneous tissues with a fine cannula. The more modern method was introduced, or at any rate extended, by Recklinghausen, and consists in staining the tissues with nitrate of silver, and subsequently exposing them to the light until they are of a brownish hue. This method is largely used in histology. Sappey's recent method aims at colouring the *contents* rather than the walls of the lymphatic vessels. He has succeeded in producing a dark colour sometimes approaching to black, but he does not state in his magnificent work on 'L'Anatomie, Physiologie et Pathologie des Vaissaux lymphatiques' what injection materials he used. I have tried a ½ per cent. solution of nitrate of silver with good results.

The lymphatics are usually injected with mercury, which by its great

divisibility easily penetrates into the thinnest vessels. The mercury must be carefully purified by filtering it through chamois leather. The thoracic duct may be injected with coloured tallow. Limited injections of the subcutaneous lymphatics may be made by throwing in a solution of alkannet by means of a hypodermic syringe.

Apparatus.—This is composed of: 1, a glass tube about a yard long; 2, a small glass funnel through which the mercury is poured into the glass tube; 3, a thick india-rubber tube fitted to the narrow end of the funnel; 4, a stopcock tube which fits the india-rubber tube; 5, a small glass tube of which one end fits the stopcock tube and the other is drawn out to a capillary point: 4 and 5 must be fitted to each other by surrounding the large end of the glass tube by waxed silk, and sufficient turns must be made so that the end of the tube must be a little larger than that of the opening of the stopcock tube. Sappey recommends that the interior of the stopcock tube should have a screw traversing it, as this more firmly fixes the glass tube. The tube is introduced into the stopcock apparatus by rotation, and the operator must make sure that it is firmly fixed, and allows of no escape. The apparatus is then vertically suspended, so that the capillary end of the little tube is below the level of the subject, and the flexibility of the india-rubber will permit the glass tube to be put in any direction. The long glass tube is then filled with mercury through the funnel, the column of which must vary in height, and consequently in pressure, according to the results one wishes to obtain. Great pressure is often advantageous and necessary, but sometimes it ruptures the vessels.

To inject the Lymphatic Vessels a lymphatic trunk must be sought where anatomy teaches they may be met with, but the proceeding may be facilitated by pressing with the finger or the back of the scalpel, from below upwards, in the course of the lymph stream. The skin is to be carefully divided, and with a little patience lymphatic trunks may be found in the subcutaneous cellular tissue. The capillary end of the tube must be introduced into one of them (this is not always easy, as the vessels yield before the pressure), and the stopcock being turned, the mercury rapidly enters as far as the first ganglion. It sometimes happens that the vessel is missed and the tube is introduced into the cellular tissue. This is generally easily recognised, and the mistake must be put right before proceeding with the injection. The tube being in a lymphatic trunk, should the mercury cease to flow, its progress may be assisted by gentle frictions with the handle of the scalpel. When the mercury has reached a lymphatic gland, it often happens that it will not flow through it. A similar pressure with the handle of the scalpel will often assist it to run through into the *efferent* vessels; but very often this will not succeed, and it is then necessary to expose the efferent vessel or vessels and to directly inject them.

The long glass tube should be graduated so as to enable the injector to assure himself as to how the injection is succeeding. This may be done with a narrow piece of paper marked out in subdivisions of inches. The shape of the upper surface of the mercury will often indicate if the injection be progressing or not. If it be concave, the injection is proceeding; but if it be convex, the process has become stopped for some or other reason. Should the mercury pass too rapidly along the tube,

it indicates a rupture of the vessel and an extravasation in the cellular tissue. The injection must be stopped and the ruptured vessel carefully dissected out and tied, and the injection must be recommenced. Sometimes it is necessary to increase the pressure, but the amount of this which is necessary to a successful injection will be best learned by experience.

The injection of the lymphatic net-works is a part of practical histological study, and is usually accomplished by means of the puncture method, and the student must refer to the various works on histological technics for instruction on this subject.

The best places in which to inject the lymphatics of the skin have been given by Sappey, and named '*places of election.*'

1. On the skull, the situation where the lymphatics can be best injected is placed between the lambdoid and parietal sutures. The ear can be well injected by puncturing the auricle either at its outer or inner surface. One puncture is sufficient to inject one surface of the auricle.

2. On the face the median line is the best place for the injection of the lymphatic capillaries. The root and the alæ of the nose and the commissures of the lips are the spots in which the punctures should be made.

3. In the limbs the superficial lymphatics can be injected by puncturing the fingers and toes on their two lateral aspects; and the palm of the hand and sole of the foot may be injected by puncturing in various points of their surfaces. To obtain the fullest possible injection it is best to make ten punctures, i.e. to inject each of the lateral surfaces of the five fingers or toes. The palm of the hand and the sole of the foot are very difficult to inject while they are covered by their epidermis, as this membrane, being thicker in these situations, the tube becomes blocked and prevents the flow of the injection. It is necessary therefore to scrape away as much as possible of the epidermis.

EMBALMING.

This, one of the 'lost arts,' was well understood by the ancient Egyptians, but the processes which they employed were, as far as can be ascertained, somewhat complicated. Modern nations have for a long time past practised evisceration in conjunction with the use of various preservative materials. Within the last twenty years several processes have been successfully employed, such as those of Segato, Abbate, &c.; but the materials used and the methods employed have been kept strictly secret.

As it may be desirable to embalm bodies or fœtuses, or to prepare the viscera for anatomical purposes, a brief account of the best known methods will here be given.[1]

A previous hydrotomy will render the subsequent operations more successful; but as this is a somewhat inconvenient and lengthy operation, it may be dispensed with. A strong solution of chloride of zinc or carbolic acid is to be injected, and as much of it thrown in as the vessels will hold. In hot weather, and if the body be large, or if the cause of death be from any blood poisoning, a larger quantity and a greater strength will be required to obviate the tendency to rapid putrefaction. In young, thin

[1] A good account of embalming, as far as known at its date of publication, will be found in J. Magnus's *Das Einbalsamiren d. Leichen in alter u. neuer Zeit*, 1839.

subjects and in cool weather the zinc chloride may be diluted to the proportion of two-thirds zinc to one of distilled water. The injection should be commenced by throwing in a weaker solution so as to prevent the narrowing of the vessels which would interfere with the injection passing into the smaller vessels. This should be followed by a stronger solution. A mixture of alcohol of about 90°, and one-fifth its weight of carbolic acid, is also a good preservative mixture, but the quantity required equals one-half the body weight, and consequently, alcohol being dear, this would be an expensive material to use. The limbs should be freely flexed and extended, so that the fluid may flow easily into their vessels. A successful injection may be recognised by the distention of the superficial veins of the chest and arms, and by the escape of a darkish fluid from the nostrils and perhaps from the mouth. This is due to oozing of the fluid through the vessels of the mucous membrane.

The steps of the operation and the instruments required are the same as those already described.

Results of the Operation.—As the vessels are filled the abdomen will gradually swell, the chest will become more full, the eyelids and face will become puffy, and the superficial veins will be full and dark from the blood in them. After a few hours the skin becomes very pale and parchment-like, and this is a certain evidence of the success of the operation. The puffed aspect of the face and the other signs just mentioned will have disappeared in a few days, but after several weeks the tip of the nose, ears, and ends of the fingers begin to dry, shrivel up, and become brownish. This is probably due to the small size of the vessels of these regions, and the injection consequently not having thoroughly penetrated them. The student will note that no evisceration is required in this method, the body being injected by the carotids or femoral.

Brunetti's method for preserving viscera or pathological specimens consists of the following: 1, the washing of the preparation; 2, the removal of all fatty matters; 3, the tanning; and 4, the desiccation.

Step 1 consists in an hydrotomy of the blood-vessels and excretory canals, and a subsequent removal of the water by a stream of alcohol.

Step 2 consists in following up the alcohol injection with an injection of ether for some hours. The ether penetrates the interstices of the tissues and dissolves the fat. At this stage the preparation may be preserved for any length of time, but before proceeding to the final steps it should be plunged in ether.

Step 3 consists in the injection of tannin dissolved in boiling water, after the blood-vessels have been washed with æther, and after the æther has been removed by the injection of distilled water.

Brunetti accomplishes *Step* 4 by placing the preparation in a vase of suitable size, which is filled with boiling water, so that warm, dry air may penetrate the preparation. He uses a reservoir in which air is compressed to about two atmospheres, and which communicates by a stopcock and tubes with a vase containing chloride of calcium, and with another which is heated. It is then put in connection with the vessels and ducts of the preparation, so that a gaseous current permeates the preparation, and in a little time expels all the fluids. The operation is now complete, and the part or organ remains light, supple, retaining its size and relations, and solid elements, there being no longer any fluid in it. It will last inde-

finitely, and may be handled without fear. The surest and easiest method to get rid of the epidermis is by maceration; the injection will then become quite easy. The 'seat of election' is in the centre of the palm and of the sole.

A previous hydrotomy for some hours will produce a slight œdema and distend the lymphatic vessels, which will then be more easily recognised; and if the subject be placed for some hours in water, the lymphatics will also become well distended by imbibition.

ANATOMICAL LABORATORY, OR DISSECTING ROOM AND ITS APPLIANCES.

The dissecting room should be large and airy, and situated in a part in which free ventilation is permitted, and should of course be so looked after as to prevent creating a nuisance in the neighbourhood. It should be lofty and lighted from the top, but side lights are also serviceable in some dissections. Its floor and walls should consist of some impermeable material which can be easily cleaned, and which is not very absorbent. If the walls be of slate, diagrams or drawings may be made upon them for demonstration purposes. The floor should be strewed with pine sawdust, which gives off a pleasant odour, and which to some extent acts as a disinfectant; it also will help to keep the students' feet warm by preventing immediate contact with the cold floor.

The dissecting tables should be about six feet long, of a convenient height, steady, and not too broad, i.e. about 30 inches in breadth. The stools should be of different heights, to suit different dissectors. Boards, blocks, and ropes are necessary appliances in the dissecting-room. It is better that all the wooden materials should be varnished, so as to prevent absorption of the decomposing juices of the subject, and the tables should be covered with a layer of sheet zinc. The walls of the dissecting room should be hung with good illustrations of dissections, and there should be two or three articulated skeletons suspended in different parts of the dissecting laboratory for purposes of reference, and the student should bring with him the bones of the part he is dissecting. A well furnished dissecting laboratory should be provided with dissected preparations placed in a convenient position for study around the room.

The *Anatomical Museum* should be provided with good dissections, sections, and models, to which the student can refer and examine for himself, and in the library of the college the various English and foreign standard anatomical works should be at the service of the worker. Ormsby's cranium holder (see fig. 18), which facilitates the removing of the calvarium, should also be at the service of the student in the dissecting room.

Private Laboratory.—An extra unfurnished room can readily be obtained nowadays at a small sum, and if two students be living together, the cost of this and the requisite furniture will be very small. Fœtuses, parts of limbs removed by amputation, and some of the viscera, such as the brain, larynx, tongue, &c., and the smaller animals, may, I believe, without offending the law, be dissected in a private laboratory. Common sense and decency will tell the student that these parts must be carefully preserved in spirit so as to prevent their decomposition, and they must be

excluded from prying eyes, and when done with they should be returned to the dissecting-room porter for disposal. A firm deal table painted black and varnished and fitted with drawers will answer all anatomical and histological purposes, and if the student be provided with a good dissecting case, an ordinary dissecting microscope, a syringe, and a simple apparatus for dissecting under water, he will be prepared to follow all the instructions of his books, and, in a more advanced stage, to add to the sum of anatomical knowledge.

Instruments.—A good dissecting case should be provided with three scalpels of different size, shape, and strength; with two smaller knives, one for finer dissections, and one having somewhat the shape of a cataract knife, for the dissection of the eye (these will be serviceable in histology); a brain knife, dissecting hooks, blowpipe, two or three pairs of forceps, grooved director, aneurism needles, one or two files, two pairs of scissors, a chisel, a saw,[1] and a hammer with a hook on the end of the handle. These latter should be fitted into one handle. The dissecting case should be provided with needles, string, and a small bottle containing carbolic oil, also with a hone and a hand lens. Messrs. Mayer & Meltzer, of Great Portland Street, have made for me an excellent dissecting and post-mortem case combined, at a reasonable price, in which all necessary instruments are provided in a portable form. The chisels, saw, &c., are fixed into the handle by an excellent recent patent of Mr. Mayer, and can be easily fixed on and removed. The accompanying figures will sufficiently explain the shape, &c., of these instruments, and an hour under the guidance of the demonstrator will be much more serviceable in teaching the student their uses than any written description. The large pair of scissors is provided with a movable cover for dividing the intestines.

Before proceeding to the consideration of the dissection of the various parts it will be well to give the order of dissection, which it is best to follow, and a few general rules which will be useful to the student.

Order of Dissection.—The perinæum is first dissected, and the early half of the day is usually allowed for this. The body is then placed on its back, and the other dissectors can continue with their parts, i.e. with the front of the arms and legs, and head and neck. In from two to three days the body should be turned on its face, the muscles of the back, &c., dissected, and also the spinal cord, because if this is left, as is usually done, to the later stage, the cord will have decomposed into a soft pulp, and the student will have difficulty in making a satisfactory dissection.

When the body is on its face, the back of the neck, of the shoulder and arm, the buttock, popliteal space, and back of the thigh should be dissected by the owners of these parts; the further steps will be given with the various regions.

The brain should be removed not later than the second day, and should be at once placed in methylated spirit. The skull will need to be fixed, and the best mode of doing this is by applying Ormsby's cranium holder and fixing it firmly by means of the screws.

Some dissectors and pathologists are fearful of soiling or poisoning

[1] Two keyhole saws, one straight and the other at an angle, are very useful in the dissection of the cranium. They can be adapted to the single handle contained in the box. A gouge is also of service, and an ordinary house-painter's brush of medium size is of use to smear the parts with glycerine to keep them supple.

FIG. 17.

1. Blowpipe.
2. Cataract knife.
3. Scalpel.
4. Bullet ended scissors.
5. Intestine scissors.
6. Ordinary scissors.
7. Dissecting hooks.
8. Chisel and movable handle.
9. Wire retractor.
10. Hooked forceps.
11. Dissecting forceps.
12. Saw
13. P. M. knife.
14. Elevator.
15. Ditto and raspatory.
16. Hammer with hooked handle.

[It is not necessary to figure the files, which should be of different sizes and shapes.]

their hands, and use india-rubber gloves, which are made for the purpose of protecting the hands; but these are unnecessary if the body have been properly injected with a preservative material, and if precaution be taken to protect any hangnails or cuts with collodion or with good adhesive plaster and a coating of carbolised oil; but should the student wound himself, he should squeeze the injured part so as to encourage bleeding, then suck it well, so as to extract more blood, and with it the infecting

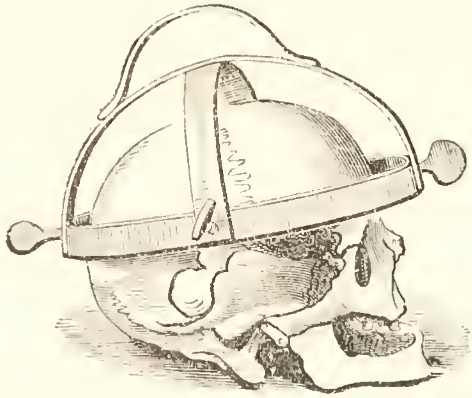


FIG. 18.—CRANIUM HOLDER (ORMSBY'S).

material, and then either cauterise with nitrate of silver, or protect it with collodion or with styptic colloid. There is more risk in dissecting subjects dead from blood-poisoning, as erysipelas, pyæmia or puerperal fever, than in recent subjects.

The student should study cleanliness, i.e. he should keep his part clean, his instruments in order, and his hands well washed and disinfected after dissection. Waterproof sleeves and apron are very useful to prevent soiling of the clothes.

METHODS OF DISSECTING, ETC.

The Skin.—The various cutaneous incisions will be given and represented with the various parts to be dissected. To reflect the skin, one of the angles of the incisions should be seized with the forceps held in the left hand, and traction should be made on it while the scalpel separates it from the subcutaneous tissue. The skin may be raised by three methods: 1, dissection, in which it is carefully cut from the subcutaneous parts; 2, by scraping; and 3, by transfixion. The latter method is rarely used in dissection. The subcutaneous tissues may be dissected separately in a similar manner, or may be raised with the skin by cutting down at once upon the deep fascia; but it is better to remove the skin first, as the cutaneous vessels and nerves have to be dissected out of the subcutaneous cellular tissue. If a large flap of skin is to be reflected, it is better to take hold of it with the hand, as a greater and more uniform traction-force is thus obtained. In certain parts of the body the skin is more difficult to remove, as, for instance, at the back of the neck, where the trapezium is closely united to the under surface of it; and in the scalp, where the skin is firmly adherent to the epicranial aponeurosis. Further instructions will be given with the dissection of the various regions.

The following five figures show the various modes of holding the knife, forceps, and scissors.

The Muscles and Fasciæ.—After the skin and subcutaneous tissues have been removed, a whitish layer of fibrous tissue is exposed. This is

FIG. 19.

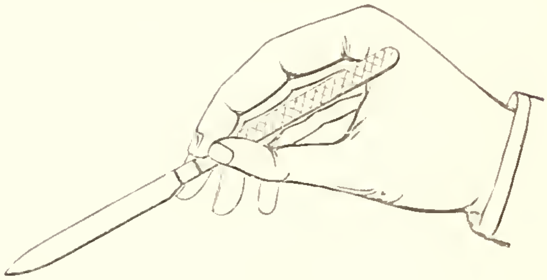


FIG. 20.

the deep aponeurosis or fascia. Generally these aponeuroses can be easily removed from the muscles which they envelope, but sometimes the muscles arise from their deep surface, and, at others, muscles are inserted

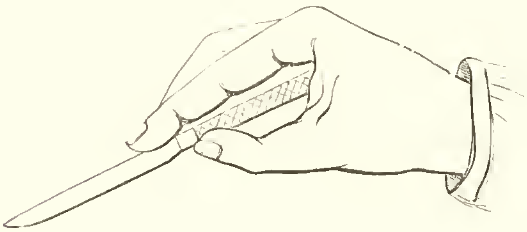


FIG. 21.

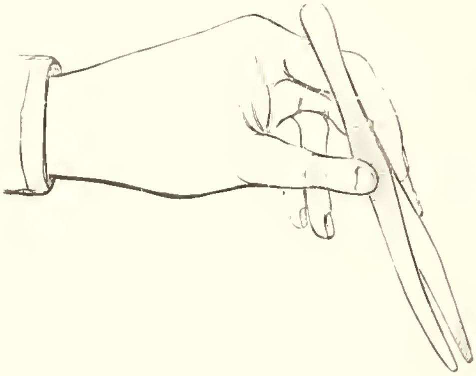


FIG. 22.

into them. When muscles are attached to them these portions of the aponeurosis may be left, and they should be removed by incisions having a direction in the course of the fibres of the subjacent muscles.[1]

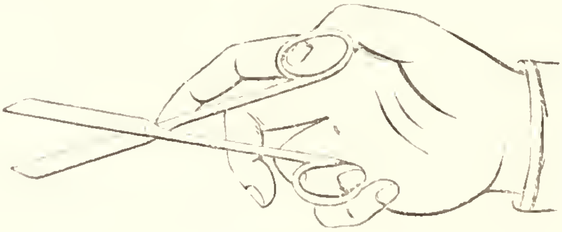


FIG. 23.

The muscles should be put upon the stretch and cleaned in the direction of their fibres; and if it be desired to make a museum preparation, the

[1] The study of the fasciæ and aponeuroses is much neglected in most schools, and having in regard their great surgical importance, this is much to be regretted. The superficial vessels, nerves, and lymphatics will be found between the layers of the subcutaneous fascia or cellular tissue, and should be carefully dissected.

muscular fibres should not be seized with the forceps, as there are usually some fibres of cellular tissue around it which may be caught hold of and the muscle thus rendered tense.

To dissect the deeper muscles the superficial ones should be removed or displaced. They can be displaced by relaxing the muscles and by fixing them out of the way with the dissection hooks; and they may be removed in three different ways:—

1. By dividing them at their middle, so that on replacing the divided parts their relations can be studied.

2. By dividing them near one of their attachments, so as to preserve their form and relations.

3. By removing with a fine saw that portion of the bone to which the muscle is attached. By this method the superficial and deep muscles can be replaced, and if desired be fixed with tin tacks, small screws, or glue, and the parts will assume their previous relations.

These different methods are each applicable in certain regions; and in the various sections of this work the best steps for reflecting the muscles will be given.

When the superficial muscles have been reflected their deep surfaces must be studied, and all vessels and nerves entering them should if possible be preserved.

In studying the muscles the student should become familiar with their attachments, actions, relations, vascular and nerve supply; and in dissecting the fasciæ he should make out their attachments, the parts which they enclose and separate, and also the fasciæ with which they are continuous.

Dissection of Blood-Vessels.—As with the muscles, one should avoid catching hold of their coats with the forceps, as this will either tear them, or by breaking the contained injection spoil the look of the dissection. The back of the scalpel should be applied to the vessel, and the connective tissue should be seized by the forceps and carefully removed.

In his second year the student should dissect uninjected bodies, to render himself familiar with the normal size of the vessels as found in operating, and also to prepare him for the aspect and relations of the uninjected preparation on which he will be examined for his diploma.[1]

The *lymphatics* may be exposed either by carefully removing the skin and a part of the subcutaneous cellular fatty tissue, and leaving the lymphatics applied to the deep fascia; or one may remove the skin and subcutaneous tissue from the aponeurosis and reflect it, leaving the lymphatics adherent to the deep surface of the skin.

This latter method is best, to see the cutaneous networks. If the lymphatic vessels have been injected with mercury and the preparation dried, there is little need to cleanse the connective tissue from them, as this has become transparent by desiccation, and the mercury can be seen through it. The vessels must not be wounded, as the mercury will escape through the puncture; and the dissection should be made from the radicles towards the larger trunks, and in a direction parallel with them.

After the preparation has been injected and dried, it should be preserved in a vertical position.

In studying the blood-vessels, the student must learn their origin, course, branches, anastomoses and relations.

[1] At the College of Surgeons students are nowadays examined on the injected subject.

Dissections of Nerves.—The rules given for the arteries are good for the nerves. In fœtuses the nerves are easily dissected, and good preparations of the nerve plexuses can be made on them. The points to make out in nerve dissection are, their origin, the formation of the plexuses, the course, relations, anastomoses, and distribution of them.

The following method, devised by A. Paulin, and named by him 'chemical dissection,' is valuable in the macroscopic and microscopic anatomy of the brain and cord.

The *brain and spinal cord* are to be macerated in 50 parts of water to 1 of potass bichromate and 2 of sulphate of copper. In eight or ten days they become of a yellowish green; they are then put for two or three days in a 100 per cent. solution of sulphuric, or better, of hydrochloric acid. In two or three days the greenish colour disappears; but hydrochloric acid often causes the parts to assume a soapy consistence. This disappears after about twelve hours' maceration in a 1 per cent. solution of chloral. If now there be difficulty in separating the parts they should be put for some hours in equal parts of glycerine and water, and then in pure water until the next day.

It will then be found that the pia mater can easily be separated; that the white substance can be divided in its entire length into cords or strands; that the white and grey substances can be separated without destroying the commissures; that the posterior cornua may be isolated; and that the central canal can be divided in its whole length.[1]

VISCERA.

The *hollow viscera*, such as the stomach, intestine, and bladder, may be distended with air or with warm tallow. This will render the dissection of the muscular fibres more easy. To examine the interior of these organs the injected matter must be removed, the mucous surface washed, and the aspect of the interior of the organ regarded through the magnifying lens. Permanent preparations of the stomach, intestines, bladder, &c., may be made by distending them with air and hanging them up to dry. When dry they should be varnished, and, if necessary, windows may be cut out of them to show the structure of the interior. The junction of the ilium and cæcum, and of the gall bladder and duct, &c., make instructive preparations.

Joints.—Before cutting into the ligaments the actions of the joints should be studied so as to observe what ligaments are rendered tense, and what relaxed, in the various motions of which the joint is capable. The connective tissue should be carefully removed from around the joint, and its interior may be injected with air, water, or warm tallow, so as to make out any hernial pouches of the synovial membrane; and when the joint is laid open the injection material should be washed away, in order to study the joint surfaces.

Bones.—After removing the periosteum in parts, to notice its varying thickness, the bones should be sawn *in situ*, or separately, longitudinally and transversely, so as to make out their structure. A prolonged maceration followed by subsequent drying will enable the student to follow the

[1] The modern methods of preparing and preserving the brain and spinal cord will be given with the chapters in which their dissection and anatomy are described.

accounts of the architectural structure of the cancellous tissue, as then, the animal matters being removed, the contours of the earthy parts of the bone which are left will be much plainer. Where it is necessary to follow nerves or vessels through the bones, the latter, after being placed for two or three days in spirit, should be put into nitric or hydrochloric acid, diluted with about one-third of water, so as to soften the bony tissue and enable the nerves, &c., to be traced through the bone.

The student should practise holding the scalpel, and dissecting with the left hand; he will thus acquire *ambidexterity*, which may prove serviceable to him as an operator; and when he has done dissecting for the day, he should cover his part, bringing the skin together over it, and wrapping it in a bandage which has been dipped in saturated salt solution or in carbolic acid lotion.

Parts which are intended to be preserved should be dissected under spirit and water, as the connective tissues are floated up and can be more readily seen and removed. Small parts or organs may need the use of the dissecting microscope, the directions for the use of which will be found in Carpenter's work on the Microscope, in Beale's work on the same subject, or in Frey's 'Microscopic Technology.'

METHODS TO PRESERVE ANATOMICAL DISSECTIONS, ETC.

There is no work to which one can refer for instructions in these matters. There are a few articles on isolated parts of the subject which are excellent so far as they go; and to these and personal experience I am indebted for the following incomplete description.

It is presumed that the subject has been hydrotomised, that the venous and arterial systems, &c., have been injected either generally or partially, and that after injection the subject has been naturally or artificially cooled and exposed to the air, so as to become desiccated.

Preparation.—The parts having been dissected, and the organs sufficiently isolated, if thought requisite, the deep fascia should have a longitudinal cut made in it on the surface which will not be exposed when the dissection is mounted or imbedded, and it should be exposed to a current of cool air till it is sufficiently dry to be painted, varnished, and mounted, if necessary.

Preparation of Bones.—If it be desired to prepare single bones, or the bones and joints of a limb, or part of the entire skeleton, the proceeding must differ in some points. All the soft parts, including the periosteum, must be removed from the bones, which must be brushed or gently scraped clean.[1] This process will be considerably facilitated by previous maceration in running water. The fatty parts in the interior of bones should be removed before the preparation is exposed to the drying method, which, by the way, can be accelerated in a hot air chamber.

To remove the medulla, &c., contained in the cancellous tissue and medullary canal, several holes should be pierced by means of a drill, and these should communicate with the medullary canal or with the spongy substance at the end of long bones. At the lower end of the femur five or six holes will be necessary, and it is better to make them at a part which

[1] Maceration in running water is one of the best modes of getting rid of the soft coverings of bones.

will be hidden when the preparation is finally put up. The holes being made, a metal cannula is fitted into one of them, and water is forced through by a strong pressure. This stream washes out the medullary tissue, and should be continued and repeated for several days, according to the size of the bone.

If, as in the vertebræ, and carpal and tarsal bones, there be no medullary canal, the bones should be pierced from above downwards, so as to form an artificial canal, and may then be washed out. Afterwards, the hole may be closed with putty or plaster of Paris. The tarsal bones may be pierced from behind forwards by making two canals with the drill; one through the os calcis and cuboid, another through the astragalus, scaphoid and first cuneiform. Three transverse canals should be drilled; one through the cuboid and three cuneiforms, another through the bases of the metatarsals, and the third through their exterior extremities.

The size of these artificial canals must vary with the size of the bones operated on; and when the bone is dried, these artificial orifices may be closed with plaster of Paris, putty, or gum and chalk.

Another way of removing the fatty matter of bones is by boiling or by macerating them for several days in a solution of sublimate of mercury in spirit and water; but this maceration may be obviated if one paint the bone, after it is desiccated, with several layers of the alcoholic solution of mercury. In cold weather the maceration must be conducted in a warm room, else the cold will arrest the putrefactive process, which will be too slow, and *adipocire* will be formed. If the bones come from a subject that has been injected with zinc chloride, they cannot be successfully macerated, as the zinc exerts a sort of tanning influence on the tissues. Such bones can only be cleaned by boiling or by long burial.

Finally, bones may be cleansed and all grease removed subsequent to maceration by exposure to the sun, by frequent washing in soda or chlorine water, or by immersion for a few days in sulphuric æther, which will dissolve out all the grease. They should then be washed and hung up to dry in the sun for a few days in the summer, but in cold weather they should be exposed to the action of hot dry air.

If the bones be buried for some time, and especially if they be placed in an ant heap, the soft and oily parts will be removed, and they will be, to some extent, bleached; but this will depend upon the nature of the soil in which they have been placed, and upon the amount of the sun's rays to which they have been exposed. Aqueous solutions of soda or of chloride of lime are good artificial bleachers and cleansers.

To articulate Bones.—Holes having been drilled, as already indicated, or in any required direction, the bones are to be connected by catgut or pieces of strong waxed twine and knots, placed at intervals to prevent the bones becoming displaced. The femur may be articulated to the acetabulum by a screw and clamp, or by a strong piece of india rubber around the margin of the acetabulum and head and neck of the femur. The humerus may be joined to the glenoid cavity of the scapula by a thick india-rubber band, or by letting in a screw or thin piece of metal between the two; but these latter modes interfere with some of the movements of which the joint is capable. The examination of some well articulated skeletons will teach the student more than any written description. The lower jaw is usually attached to the temporal bone by a spiral spring. In

connecting movable bones, the method employed should always have regard to their natural motions.

Desiccation.—The bones having been prepared as indicated, the dissected piece should be dried. This is effected by placing the part on wooden frames and carefully separating the various structures from each other by means of fine threads, or horse hair, pieces of cork, wood, or glass, and exposing them in a room with the windows open, so that the air may circulate freely between its various parts. If the weather be moderately warm, desiccation will be complete in three weeks or a month. The process may be hurried by having a fire in the room, but the preparation should never be exposed to the heat of the sun, because the fat will ooze out and soil the preparation.

Examination of the Preparation.—When the preparation is dry it should be carefully examined, and the parts put in their normal position and relations. If any nerve filaments have been torn, they should be delicately joined with thread, which can subsequently be coloured white. Many museum preparations have coloured threads representing the injured nerves.

Mounting.—These dry preparations should subsequently be mounted on boards or blocks, and be kept in place by steel or copper hooks placed in convenient positions. They should then, after being painted and varnished, be placed in a glass cabinet, and be dusted occasionally.

Most of these *dry* preparations in time become much shrunken, so as to be of little anatomical value in the study of their respective relations.

Painting.—The preparation being mounted, the arteries, veins, nerves, and excretory canals should be coloured: the veins blue, the arteries red, the ducts yellow or green, muscles reddish brown, and the nerves white. Two or three fine brushes and some good oil paint are all that is necessary.

It is best to paint first those parts of which the colour will predominate in the preparation. These are generally the muscles, and their tendinous ends should be tinted a pale yellow-white. The finer vessels and nerves should be coloured with small brushes, and one should be careful to confine the colour to the organ for which it is intended. The best way to do this is to place a sheet of paper or thin cardboard under the part being painted. If a neighbouring part has been soiled, it should be allowed to dry and then covered with the colour proper to it, or the paint may be removed by rubbing it with a brush dipped in essence of turpentine.

Varnishing.—When the preparation is painted it should be again submitted to desiccation for several days in a room in which the windows and doors are open. In about a week the paint will not come off on the fingers, and then is the time to varnish the preparation.

The object of varnishing is not only to give a brighter aspect to the preparation, but also to avoid the action of moisture and of insects on it, to give a certain transparency to the parts, and to allow of dust, &c. being subsequently easily wiped off.

There are two chief kinds of varnish which are employed, each of which is better in certain parts: *alcohol varnish*, which dries rapidly, and gives a bright aspect to the preparation, but is not good in flexible parts, nor if it be desired to use the preparation often. The layer which it forms is brittle, and it should only be used for voluminous organs, for the bones, and for corrosion preparations.

There are several commercial varnishes which are more supple, but some of these dry more slowly, and on account of this inconvenience are not better for most purposes than the alcohol varnish.

Copal Varnish is the best; it is supple and lasts a long time, it dries slowly, and is very serviceable for flexible organs which have to be moved about. It has the inconvenience of rendering somewhat brown the various parts to which it is applied, but this is not of great consequence provided the nerves be not coated with it. To varnish a preparation a layer must be passed over it; this must be allowed to dry completely, and then a second, third, fourth, &c. put on; the coatings should be applied according to the amount of polish that one wishes to give to the preparation. If the alcohol varnish be employed, the preparation must not be breathed upon, because water precipitates the resin of the varnish, and tarnishes the preparation. The brush should always be passed in the same direction and with a free hand, avoiding dabbling, as by this method air bubbles are prevented from forming and spoiling the preparation.

Jallet's Method for drying Preparations. 1st Step.—If the preparation contain fatty injection matters, it should not be plunged into the warm solution, which will be presently given, but should be placed in a cold solution of the same material for at least four minutes. This solution should be renewed three or four times during that interval.

If the preparation have not been injected, or if the injected matter contains no fatty material, the preparation should be plunged five different times, for three minutes during each time, in a saturated boiling solution of alum, being careful to let it cool between each dipping. Afterwards when the saturated alum solution has completely cooled, the preparation is to be placed in it for three minutes or less. This method has the advantage of allowing the alum to penetrate in considerable quantities into the muscles.

2nd Step.—For the hollow viscera, a mixture of fine sand, which has been sifted and washed, and water is introduced into the vessels when it is of the consistence of a soft paste. This may be done with the syringe or with a funnel apparatus. When the preparation is dry the sand may be emptied from it by thorough shaking.

If it be desired to make sections of the hollow viscera, their interior should be oiled and then filled with a mixture of fine plaster and water. The sections can then be made and the plaster removed.

3rd Step.—To remove the fat from a preparation which is being desiccated, the fatty parts should be covered with a thick paste made of starch and water. The preparation should be exposed to the sun, which causes the water to evaporate. The starch absorbs the fat while the water evaporates. This process should be repeated until all the fat is removed, when the starch is to be taken off with a brush. This paste is best applied when cold.

Jallet paints all the organs with a coat of white before putting on the colour natural to the part.

Wet Preparations.—These are much more commonly employed now-a-days. It is only necessary to make a good clean dissection, to embed the parts in plaster of Paris, which may be coloured, and to place them in strong glass or varnished earthenware receptacles of various shapes and sizes. They are then covered with a solution of spirit and water, and

evaporation is lessened by applying a glass cover which may be retained in place by a stout india-rubber band. A saturated solution of common salt or sugar is a less expensive and very serviceable preserving medium, but moulds are apt to form in any of these materials unless the air be rigidly excluded. The addition of some germicide, as salicylic or carbolic acids or thymol, may check the formation of moulds.

Deep incisions may be made at a few points on the under surface of the muscles or viscera of large preparations for the better penetration of the preserving fluid.

For *Permanent Preparations*, glass receptacles of various shape, cylindrical, plain, ovoid, &c., should be used, and those selected in which the preparation can be best seen. The parts are placed in the desired position by glass rods, horse-hair, ivory, or metal pins, and the bottle carefully filled with the preservative liquid. The preparation should be well covered, air should be excluded, and the open mouth of the receptacle should be covered with tinfoil or with thick sheet-lead, and then with a piece of bladder which has been previously macerated, so that it can be well stretched over the mouth of the bottle. This is then tied to the groove around the neck of the bottle, but beneath it it is well to close any holes in the lead which have been made to attach the preparation with sealing-wax, so as to prevent evaporation; and the whole should have a coating of Brunswick black or varnish. A second layer of bladder and varnish is requisite in permanent preparations. Wet preparations keep best where sunlight can reach them, in dark places they assume an unpleasant dark colour, especially nervous and ligamentous structures.[1]

Preserving Specimens in Paraffine or Wax.—Glycerine jelly and other materials have been used for permanently putting up certain anatomical preparations which are not too large. The human brain and liver are too large to be thus preserved. M. Fredericq of Belgium macerates the specimens for several days in pure alcohol, and then in essence of terebinthine. They are then plunged into a heated solution of paraffine or wax. M. Duval recommends heating the preparations in azotic or chromic acid before plunging them in the paraffine.

The label or description should then be affixed to the receptacle, but should not interfere with the view of the preparation. For small preparations, stoppered bottles answer very well, but their usual round shape interferes with a correct view of the specimen because of the refraction of light caused by the curved surface of the glass. For this reason flat-sided vessels should be used, and the preparation so fixed that it can be inspected while placed flat on the table or when put upright.

[1] It is much better, except in the case of dry preparations, as of bones, &c., to substitute a glass top for the tinfoil or sheet-lead, as the preparation shows better on account of the extra amount of light admitted. The glass top should be cemented down with a mixture of *old* gutta percha, 5 parts, and asphalt, 4 parts. These should be melted together and applied when hot. The edges of the glass cover are previously ground, and it should be immersed in warm water and dried just before application. The back of the glass jars may be painted with pale blue or lavender, which help to lighten up the preparation.

HINTS ON HOW TO STUDY ANATOMY.

The student frequently wastes much valuable time for lack of knowledge of a proper method on which to study a given subject. After many years' experience in learning and teaching, I can recommend the following plan, as one which will lessen the labour and expedite the progress of the learner.

Should the dissector not possess some knowledge of biological terms (a somewhat unlikely circumstance, it is to be hoped, in these days of more extended and better teaching of natural science), he should, the evening before he commences dissecting a part, get a moderately good knowledge of these and of the bones of the part he is about to dissect. He should do this with his bones and a good osteology before him. Then he should read about thirty pages concerning the part he is to dissect on the morrow, and he will enter the dissecting room with some pleasure to commence his task. These thirty pages are to be again gone through while he is dissecting, and he should not proceed further until he is thoroughly master of that portion of his work. By adopting this method he will, by steadily dissecting even only three hours a day, acquire, in the course of three months, a solid knowledge of a certain portion of anatomy. In the evening he should read some systematic work on the part he is dissecting, the best English works being those of Quain and Gray. This method should be repeated daily; but on each occasion he should recapitulate and examine himself on the previous day's work, and at the end of the week he should go over all that he has done during the previous days. Any difficulties will be smoothed for him by the demonstrators, whose attention he should draw to all anomalies, at the same time noting them in his book. Surface markings, bony prominences, &c., he can test on himself or on a fellow student. Frequent recapitulation and self-examination are necessary in a difficult subject like anatomy.

With regard to the lectures on anatomy, and with reference to note-taking, the student must be advised to attend the former as regularly as possible, otherwise he will lose the sequence of the lecturer's thoughts; but his notes should be short and to the purpose. To effect these desirable objects he should ascertain the programme of the lectures, so as to read up in his textbooks the subject for the day, before the lecture begins, because by so doing he will more readily understand the lecturer, and will know what notes to take, i.e. should the matter of the lecture be contained, as much of it must of necessity be, in his anatomical handbooks, he need not take that part of the lecture down unless the lecturer has put the matter in a new light; but any novel statements and ideas will strike the student who is thus præ-prepared, and he will make a note of them.

Should the student be waiting for a part, he should look at others dissecting the part on which he will have to work, and should examine any preparations or models in the dissecting room, referring to the plates in his handbook; but any leisure time can well be filled up by thoroughly mastering his osteology, as then the attachments of muscles, to recollect which is generally considered difficult by students, will become much easier.

When dissecting, the student should not waste his time in making a

pretty dissection unless the preparation is intended to be preserved. He should bear in mind that his object is to *understand* anatomy for practical purposes, and his aim should therefore be to know all about the parts he is dissecting: where they come from, where they go to, their relations, distribution, &c.; as this is the knowledge which he will have to apply hereafter, and which will be of great service to him. Another useful object in dissecting is that the practice should give him the command of his fingers, and prepare him for the use of the knife and forceps for surgical purposes.

Drawing, if the student possess the power, will be of great use to him in anatomy, histology, and subsequently in the wards and post-mortem room; and should he know enough of photography, modelling, and making casts, such knowledge may prove very serviceable in his anatomical studies, and in his clinical career.[1]

In his second, third, and later years of study the diligent student should be in a position to do some original work, and should he show an aptitude and desire for such undertakings, he will find that an interested and competent teacher will encourage him in his endeavours.

During this period of his curriculum he should pay frequent visits to the dissecting room and museum, so as to refresh and add to his anatomical knowledge.

Applied Anatomy should now be diligently studied, and the examination of frozen sections through various parts of the body, in adults of both sexes, at various ages, will teach much to an earnest student. Nowadays every good museum is supplied with such sections.

In the wards and out-patient rooms the learner will have ample opportunity for studying the varying relations of the viscera to the surface in different positions and states (of motion, locomotion, respiration, &c.), in health and disease. This branch of anatomical study is too often much neglected. Its great practical importance should stimulate the would-be practical man to master it as soon as possible.

FROZEN SECTIONS.

Much information regarding the anatomical relations of organs and structures in the body has been obtained from studying sections made in various planes and through different parts of the subject. Sections through the fœtal trunk can be made simply by first hardening it in spirit or chromic acid, &c., then dividing it with a knife in the direction desired. In the adult body, however, this cannot be done on account of its size and the nature of the tissues to be divided, except in the case of the extremities, sections of which may be made by hardening the soft parts in spirit and then dividing them with a knife, the bone being afterwards cut through with a saw. The method of hardening the adult body which suggests itself as being the simplest and most practicable is that of freezing. This process was first employed by Edward Weber in 1836,[2] and

[1] Dr. Tripier, a surgeon of Lyons, has devised a mode of drawing on glass which is excellent for teaching purposes. His paper is in the *Lyon Médicale* for August 1881.

[2] Serres appears to have really been the first to use this method in his *Recherches sur le cerveau*, 1820, and Pirogoff was the first to use it on a large scale in his *Angewandte Anatomie d. Menschlichen Körpers*, 1838–40, and *Anatomia Topographica*, 1852. Jarjavay also used it in 1856 in his *Etude du canal de l'urètre*.

has since been more or less extensively carried out by Pirogoff, Luschka, Legendre, Henle, Braune, Rüdinger, and other continental anatomists; but in this country it has never been practised to any extent till about two years ago, when it was practised extensively in the Royal College of Surgeons of England.[1] Experience has shown that, in order to obtain good sections, the body requires to be frozen till all its tissues become of a metallic hardness. This effect may be produced by subjecting it to a temperature of from $-15°$ to $-18°$ Cent. for about seventy-two hours. In cold countries, such as Russia and even some parts of Germany, all that is required during a severe frost is to expose a subject to the air for about sixty hours, or even shorter, when it will be completely frozen and ready for sectioning. In this country, however, such low temperatures never occur, so that we require to employ artificial means of freezing. Of these the simplest and generally the most convenient method is by means of a mixture composed of salt and ice. In this way a minimum temperature of $-18°$ Cent. or Zero Fah. can be obtained, but in practice it is almost impossible to get the ultimate degree of cold which can be produced by the mixture. We are, however, able to reduce the temperature of the air round the body to about $-12°$ or $-14°$ Cent., which is sufficient to freeze it hard enough for sectioning in about three days. The action of salt and ice as a freezing mixture is owing to the salt causing rapid melting of the ice. The conversion of the water from the solid to the liquid state is attended with an absorption of heat which is supplied by surrounding substances. The subject has, therefore, to be placed in relation to the mixture, so that the heat may be abstracted as much as possible from the former alone; means have also to be taken, which will be afterwards described, to prevent the surrounding atmosphere from supplying heat to the melting mass. It will thus be apparent that freezing a subject can be best accomplished when the atmosphere is coldest, in fact, during a severe frost.

We must now consider the *modus operandi* of section-making. First, then, regarding the subject or material. In selecting a body for freezing it is desirable to get a fresh, well-developed subject, not beyond middle age, which has not been in contact with alcohol. The necessity for this latter precaution is obvious. Spirit has a very low freezing-point, consequently if the subject has been covered with a spirit cloth, or has even been exposed to the vapour of alcohol, some will have been taken up by the tissues, which will not freeze at the temperature that would otherwise suffice. Care must also be taken to prevent salt or salt water coming in contact with the subject, as that would render it more difficult to freeze on account of the freezing point of salt water being lower than that of fresh water. An injection of wax and lard may be run into the arteries and veins to distend them.[2] To do this the body requires to be placed in hot water till the tissues are warmed, so that the injection mass may run freely in the vessels. The arteries may be injected from the femoral, but the veins require to be injected from the extremities—one of the large superficial veins on the dorsum of the hand and of the foot answers. An injection can also be thrown into the veins of the trunk by making an incision about five centimetres long through the umbilicus, and carefully

[1] See *British Medical Journal*, vol. i. for 1879.

[2] Legendre used red for the arteries and black for the veins.

separating the structures without displacing them till the vena cava is reached; this should be opened on its anterior surface, the injection tubes inserted, and the injection made both upwards and downwards. If this manipulation is done carefully the parts will be very little disturbed. An injection mass of plaster of Paris and size is not satisfactory for frozen sections, from being hard, ridged, and consequently brittle when set. The blood-vessels having been injected while the body is still in hot water, the latter is now to be plunged into cold water, and allowed to remain there for a short time till the injection has solidified. The injection-tubes may then be removed, and after the subject has been thoroughly dried with a towel it can be placed in the freezing box, which should be made of sheet iron perfectly water-tight and only large enough to hold a body, with a water-tight lid fitting like that of a tin biscuit-box. The extremities and other parts should be arranged in their natural positions. In order to prevent flattening of the back, which always occurs unless measures are taken to prevent it, the subject may be raised slightly on two narrow bars placed under the most prominent parts of the sacrum and back. The bars will cause a depression of course where they have rested, but this is better than having the whole back flattened. Another plan is to place a quantity of soft sawdust in the bottom of the box so as to distribute the weight of the subject equally over the whole surface of the back. The lid may now be placed on the box and the subject closed in. It is now ready for freezing, which may either be done in a yard or a large sink. The box should be raised four or five inches off the ground or base of the sink by means of four bricks, the space under it being filled up with ice. A wooden frame, thirty centimetres larger than the box and seventy centimetres in depth, should now be placed round it. A metal tube, about seventy-five centimetres long and about six centimetres in diameter, should be secured perpendicularly to the side or end of the box. Into this tube a thermometer is suspended by means of a string, so that it can be taken out from time to time during the freezing process; the upper end of the tube should be closed with cotton wool to prevent communication with the outer air. The object of the tube and thermometer is to provide a means of ascertaining approximately the temperature within the box, and so of observing the activity of the freezing mixture. The ice and salt have now to be mixed. Six hundredweight of ice will be required to surround the box properly. The ice should be broken up into small pieces and rapidly mixed with two hundredweight of coarse salt. The mixture is then to be placed round and over the top of the box till it is surrounded to the depth of about thirty centimetres, that is, till the space between the sides of the box and frame has been completely filled and there is a thick layer over the lid of the box. The whole should finally be covered over with two or three layers of blankets and with straw, so as to keep the melting mass from the air, and, so to speak, compel the ice to abstract the heat it requires to absorb for its conversion into water from the interior of the box. If the thermometer be examined in two or three hours afterwards, it will probably be found to stand at about $-15°$ Cent., or even lower. After about eight hours the temperature will have risen a few degrees; if to higher than $-10°$, the mixture is not acting rapidly enough from having got caked together; it should therefore be thoroughly stirred up with a furnace raker or long poker. When this has been

done it will rapidly fall again. This process requires to be repeated about every two hours till about the end of thirty-six hours, when the mixture will need to be renewed. This should be done as rapidly as possible and the same quantity of ice and salt used as before. After a few hours the mixture will again require to be stirred up every two or three hours. At the end of seventy to eighty hours from the time the process was first begun, if the temperature has been kept at an average of about $-12°$ to $-14°$ Cent., the subject should be completely frozen, so as to resemble a piece of metal in hardness and ready for cutting into sections. It must now be rapidly taken out of the box, and if transverse sections are to be made, placed upon a table or bench of a convenient height, or if it is to be divided longitudinally, upon planks of wood placed side by side on trussels, so that the saw can be worked vertically, the end as it protrudes with each stroke beyond the posterior surface of the body passing between the planks carrying with it the sawdust, which falls into the pit below.

Before the sections are cut they must be marked off in the direction and of the thickness they are to be made. This can easily be done by scoring the surface with the point of a knife guided along a ruler, in the same way that paper is ruled. The thickness of the sections depends upon their size and the nature of the structures through which they pass. As a rule longitudinal sections through the whole trunk should be five centimetres thick; transverse sections can be thinner, but should not be much under 3·5 centimetres; sections through the extremities may be much thinner, indeed they seldom require to be over 1·5 centimetre, except those through the upper part of the thigh, which are better to be about 2·5 centimetres thick. The sections are cut with a fine-toothed broad saw about sixty-six centimetres long. A narrow bow saw has an advantage over the broad saw in working with less friction on the surface of the sections, but from being more difficult to guide and easily twisted, the surface it leaves is not so smooth and regular as when a broad saw is used. The saw should be held quite loosely and lightly in the hand and allowed to follow in its own groove, being merely pushed on and drawn back with a light swinging movement of the arm; whenever it is forced or twisted in its course, as it almost invariably is by amateurs, it sticks and does not work smoothly. Anyone who is not well accustomed to using a saw would learn much valuable experience in sawing by procuring a log of wood thirty centimetres in diameter and practising making transverse sections of it before attempting to cut sections through a body. The experience gained will amply repay the trouble, and perhaps prevent a valuable section of the body being spoiled. As little time as possible should be lost after the body has been taken out of the box before the sections are made, and if the number required cannot be cut in an hour and a half, or at longest two hours, it is better to replace the body in the box and continue the freezing process till next day, when the remaining sections can be made. When thoroughly frozen the subject should saw like a log of wood, giving off sawdust during the process, and almost no perceptible difference should be felt in regard to the hardness of the structure when the saw is passing through muscular tissue or when bone is being divided; unless this is the case the body is not sufficiently frozen, and the freezing process requires to be continued for a longer period.

The friction of the saw generates a certain amount of heat which causes the fatty tissues to soften on the surface of the section; the fat mixing with the sawdust forms a layer over the section, giving it an appearance as if it had been buttered. After the sections have been made, they require to be washed in ice-cold water to remove this layer of greasy débris. This having been done, the various structures will be distinctly displayed, and their relations to one another seen. If it is desired to make drawings of the sections, they should be replaced in the box separately and exposed to the action of the salt and ice for two or three hours, in order to freeze the water on the surface, and thus obtain a dry, smooth, transparent surface. The surface being frozen, it may be covered with transparent tracing-paper an l an exact tracing made.[1] If drawings are not required, the sections, after having been washed, should be placed on separate slabs or sheets of glass so that they do not touch one another, and immersed in equal parts of methylated spirit and water. The thawing process now begins rapidly, and in a few hours the sections become quite soft and flaccid. At this stage they must not be handled, as the structures are easily displaced. After remaining a week in this dilute spirit, each section should be removed on its own slab of glass and placed in fresh spirit of the strength of two parts of spirit to one of water. Another sheet of glass may be placed on the upper surface, and the section turned over, so that the spirit may get more freely at the surface which was next the glass in the first instance, it being uppermost on this occasion. In this second spirit solution the preparations may remain for about ten days or a fortnight; at the end of that time they may be taken out and placed in pure spirit, where they should lie for about three weeks before they are handled. By that time they will have become permanently hardened by the spirit. The object of using weak spirit in the first instance is to prevent shrinking of the tissues taking place, which always occurs if pure spirit is used from the beginning. If dilute spirit is used at first, it will be found that the sections do not shrink to any perceptible extent afterwards. In proof of this it may be mentioned that there are some longitudinal sections through the head, in the museum of the Royal College of Surgeons of England, made three years ago, in which the brain section still fills the bony circle of the skull completely. After the specimens have become hard they may be taken out of the spirit to have their surfaces smoothed and dressed with a sharp amputating knife or razor; care must be taken, however, not to keep them out of the spirit too long, and they should on no account be permitted to get dry. They are then ready for permanent mounting. To display them to the best advantage they should be mounted in flat porcelain dishes or trays, with ground edges and glass covers cemented down with a composition of four parts of asphalt to five of old gutta percha melted together and applied when fluid. As the mounting is expensive from the cost of the porcelain trays, it is often preferable to keep the sections unmounted in spirit. In this condition they are even better available for minute examination than when mounted. Their value for reference will be greatly enhanced if at the time they are cut, the exact

[1] A speedy though rough plan is to take a *rubbing* by placing paper over the frozen preparation and rubbing cobbler's wax over it. An exact reproduction is thus obtained in less than a minute.

part of the body through which the upper surface of each passes in relation to some well-known and fixed points be noted.

If it be desired to make the intermuscular spaces very evident, a thick section should be placed for a month to six weeks in a concentrated solution of potassium nitrate-saltpetre, which causes a shrinking of the muscular tissue.

I can recommend the following plan for making sections of fœtuses. Make quickly a mixture of 2 parts of snow or finely powdered ice, and 1 part of salt. A layer of this mixture, about three inches thick, is placed in a wooden box of suitable size and shape, the bottom of which is pierced by numerous small holes to allow the water to run off. The fœtus is placed in this ice-bed and gradually covered with a thick layer of the freezing mixture. To avoid altering the form of the thoracic and abdominal cavities, it is advisable only to place a thin layer of ice over these parts; this will not deform these cavities, and will be sufficient to freeze the skin and subcutaneous tissues.

The box is then surrounded with flannel and placed in an airy position for six or seven hours, when the fœtus will be thoroughly frozen. It is then quickly but carefully removed from the box and placed on a small rectangular table which has a groove at its middle along its length. At one end of this groove is firmly fixed an upright piece of wood with a narrow slit which reaches nearly to its point of junction with the table. Another similar vertical piece of wood slides in the groove opposite to the one just described, so that the slits of each correspond. The frozen fœtus is placed between these uprights in the required direction—longitudinally or transversely—the movable upright is kept steady by a screw, clamp, or strong string, and if necessary this small table may be clamped to a larger one to render it steady during the process of sawing. A fine saw is then passed into the slits of both uprights and the section made. This is usually very satisfactory, and the blood on it can easily be removed by a stream of cold water.

To get a good tracing of the section, a thin sheet of glass with a perfectly even surface should be at hand; also some sheets of white blotting or tracing paper which has been varnished on one side to make it more transparent. Moisten one surface of the glass and apply to it the non-varnished side of the paper. The moisture makes this side of the paper also transparent, and fixes it to the glass. Now place this papered glass on the surface of the section and take an outline of the parts forming it. This can be easily and rapidly done. Of course only the glass and not the papered surface must be applied to the section. An accurate sketch is thus obtained, which can be transferred by tracing, after removal from the glass, to an ordinary sheet of drawing paper, and the details filled in.

CHAPTER IV.

DISSECTION OF THE UPPER LIMB.

PART I.

THE THORACIC WALL AND AXILLA.

Directions.—The body being on its back, raise the thorax to a suitable height by a block, and place the arm on a board at a right angle to the trunk, the hand being supinated. The chest, wall, and axilla must be dissected and learned in from two to three days, so as not to interfere with the dissectors of the thorax; and when the body is turned, the student must dissect the superficial muscles of the back, which in most dissecting-rooms belong to the possessor of the arm.

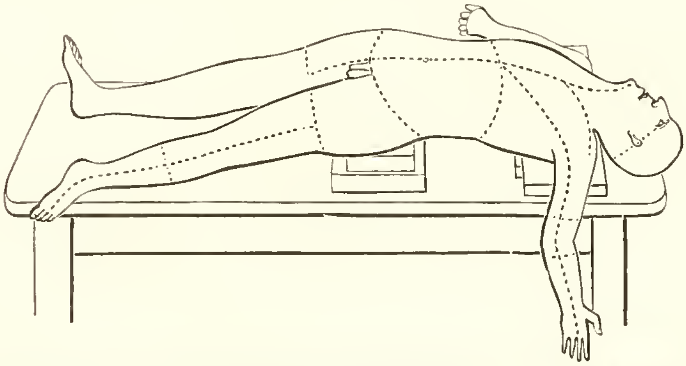


FIG. 24.—SHOWING THE POSITION OF THE SUBJECT AND THE INCISIONS FOR DISSECTING THE FRONT OF THE BODY.

Surface Markings.—Before removing the skin, the student must make himself quite familiar with the bony projections, muscular prominences, and depressions between them, which serve as landmarks, and are used as guides to the position of parts beneath the skin and subcutaneous tissues. He should also, by moving the various joints with the one hand and feeling over them with the thumb and fingers of the other, appreciate any alterations in the relation of parts produced by the various movements.

Bony Prominences.—On the front and upper part of the chest the line of the clavicle can be made out in all persons. When the arm rests quietly by the side, the clavicle is slightly inclined downwards, but when the body lies on the back, the shoulder falls back and the clavicle rises a little, the weight of the arm being removed. Near the acromial end of the clavicle, on its anterior aspect, there is in many elderly persons a spinelike bony projection. This is normal, but may be mistaken for an exostosis. Note the forward curvature of the inner half or more of the

clavicle, and the anterior concavity of its acromial part. Place the finger on the sterno-clavicular joint, and observe the ridge on the sternal end of the clavicle, which must not be mistaken for a bony or cartilaginous growth. Move the arm in various directions, and observe the great mobility of this articulation. The joint between the acromial end of the clavicle and the acromion process of the scapular spine forms usually an even plane, but occasionally there is a small bony projection on the clavicular part of the joint, or a thickening of the inter-articular fibro-cartilage, which may be mistaken for a fracture or partial dislocation of the joint. This condition may exist on the opposite shoulder, a reference to which will help to settle the doubt; but should it not be present on the opposite side, the remembrance of the fact that the condition just described may occur unsymmetrically should make the surgeon cautious before expressing the opinion that there is either a fracture or dislocation, even supposing the deformity to have been noticed subsequent to an injury. It must be borne in mind that these growths may have been the result of injury.

The spine of the scapula can be made out in its whole length, and also its acromion process. The angle formed by the meeting of the spine with the acromion is a very good place from which to measure the comparative lengths of the arms. The measurement may extend on the outer side over the deltoid to the external humeral condyle, or across the front and inner side of the arm to the internal condyle. In dislocation at the elbow, which is difficult to be made out, whether backwards or forwards, out or in, measurements from the acromion to the tip of the olecranon will be of considerable value.

In some scapulæ there is a natural failure of union between the spine and the acromion, which is developed by two independent centres, the union being effected by fibrous tissue or by an imperfect articulation. In rare cases there may be two symphyses and two acromial bones, one symphysis being between the two ossicles forming the acromion, and the other between the spine of the scapula and the acromion. The student must remember these facts, as these conditions have been, and may again be, mistaken for fractures of the acromion, and have been described as such with ligamentous union.

Flex the forearm and grasp the elbow; place the thumb of the opposite hand over the head of the humerus, pressing deeply; rotate the arm, and notice the movements of the humeral tuberosities and head. The greater tuberosity, which is external, and the lesser, which is in front covered by the deltoid, form the convexity of the shoulder. In rotation, whether in or out, it is the tuberosities which are usually felt, the head of the bone being much more difficult to make out. If the arm be raised, a portion of the head of the bone can be felt in the axilla, and at the same time the convexity of the shoulder is much diminished.

In the various dislocations at the shoulder, the absence of the tuberal prominences, the projection of the acromion, and the presence of a bony prominence below the coracoid process in the axilla, or beneath the scapular spine, will indicate the nature of the dislocation of the humerus. Should fracture coexist with dislocation a bony crepitus will be present, and if there be much swelling the diagnosis becomes difficult.

In thin or moderately stout subjects the neck of the scapula may be felt by placing the thumbs high up in the axilla, and the fingers in front

and behind the anterior and posterior axillary folds. It is, however, rarely fractured.

In every position of the humerus in the normal state the great tuberosity and external condyle look in the same direction, and the head of the humerus faces very much in the direction of the inner condyle. These facts are of service in diagnosing obscure injuries about the shoulder. About an inch to the inner side of the humerus, and just below the clavicle in the groove between the pectoralis major and deltoid muscles, the coracoid process of the scapula can be distinctly felt. The arm being pendent with the palm forwards, the bicipital groove which looks anteriorly can be felt by pressing deeply, and the shaft of the humerus is best felt by pressing the fingers deeply along its inner and outer surfaces, and between the projection of the biceps and triceps.

The student should now make himself familiar with the various bony prominences about the elbow, and should go over them again when commencing the dissection of the forearm. The internal condyle is more prominent than the external, and on a slightly higher plane. The olecranon process of the ulnar is always plainly to be felt, and is rather nearer the inner than the outer condyle. The head of the radius can be plainly felt in the integumentous pit on the outer side of the olecranon and just below the outer condyle. This is an important guide, as by its means we can ascertain if the head of the radius be dislocated or not.

The dissector should ascertain the relative positions of the condyles to the olecranon in the different movements of the elbow, and should place the thumb on one condyle, the forefinger on the other, and the middle finger on the olecranon. The elbow being at right angles, the tip of the olecranon is immediately below the line joining the condyles. In extreme flexion the tip of the olecranon is in front of this line, and in complete extension the highest point of the olecranon is immediately on a level with this line. In a dislocation of the ulna at the elbow, all these relative positions would be changed; but it is not usually so in a fracture of the lower end of the humerus or through the condyles, unless there be unusual displacements.

Occasionally there is a ring or hooklike process of bone above the inner condyle, the *supra-condyloid process.* When present it may be felt. It is a hook or ring of bone, through which pass the brachial or ulnar artery and median nerve in many mammals.

The borders and upper and lower angles of the scapula can be distinctly made out, and should be manipulated by the student.

Muscular Prominences.—Passing from the chest and scapula to the humerus on the back and front of the thorax are the pectoralis major and minor, forming the anterior wall of the axilla, both of which may be felt; and also the subscapularis covering the venter of the scapula, and forming with the latissimus dorsi the greater part of its posterior boundary. The deltoid which caps over the shoulder joint can usually be plainly defined, and on the humerus the swell of the biceps in front, and that of the triceps behind, are generally very distinct.

Axilla.—Between the chest and the arm is the hollow of the armpit, in which are placed the axillary vessels and brachial plexus of nerves. The skin covering it is in the adult provided with hairs, and large sudori-

parous and sebaceous glands. The depth of this space varies with the position of the limb. It is deepest and most prominent with the arm pendent, but if the arm be lifted, its anterior and posterior boundaries are carried up and rendered tense, and the space becomes more shallow.

The fifth rib is in a line with the lower border of the pectoralis major; the first visible digitation of the serratus magnus corresponds to the upper edge of the sixth rib; and the second visible digitation to the seventh rib. The interval between these is the sixth intercostal space, which is a good guide in tapping the chest or in counting the ribs.

As before stated, the head of the humerus can be felt in the axilla when the arm is raised, but the axillary glands cannot usually be felt if they be in a normal condition.

Depressions.—Besides the deep hollow of the axilla there are certain intermuscular spaces, which are notable landmarks. There is a slight depression between the pectoral and deltoid muscles about the middle of the clavicle. The cephalic vein runs upwards in this space, and the descending branch of the acromial thoracic artery runs down, and the coracoid process can be plainly felt through it near the humerus. Sometimes there is a second groove near the sternal end of the clavicle, which passes outwards and corresponds with the interval between the sternal and clavicular origins of the pectoralis major.

On each side of the biceps is a groove, which terminates anteriorly in a depression in front of the elbow. The inner of the two is the deeper, and is the guide to the brachial artery. Along these bicipital depressions the external and internal intermuscular septa can be felt in moderately thin subjects.

Beneath the anterior fibres of the deltoid the coraco-acromial ligament can be made out.

The ulnar nerve passes into the forearm between the olecranon and internal condyle, and injuries to the inner side of the elbow cause sharp pain along the inner side of the forearm and in the little and ring fingers, giving rise to the notion that in this position was placed the 'Funny Bone.'

Below the front of the outer condyle, and slightly separated from it, the head of the radius may be felt if the forearm be rotated.

Dissection.—Make an incision through the skin only along the middle of the sternum, another along the clavicle for the inner two-thirds, and continue it down the front of the arm about two inches beyond the anterior axillary fold, carrying it down as far as the hinder fold of the axilla. A third incision is to be made from the ziphoid cartilage to the posterior part of the axilla. Reflect this flap towards the arm.

The *fatty subcutaneous layer* or *superficial fascia* of the thorax is similar to that in other parts of the body, but in this region contains less fat.

Beneath this is a stronger special fascia, which is continuous with the fascia of the neck and upper extremity above, and of the abdomen below, and closely invests the muscles. On the thoracic wall it is thin, but is much thicker across the axillary fold. It divides into two layers opposite the mamma, one passing in front and the other behind, and numerous septa from both its layers pass into the substance of the gland and support its lobes. Fibrous processes pass from the anterior layer to the skin

and nipple, including layers of fat in their areolæ. These processes Sir A. Cooper named *ligamenta suspensoria.*

If this fascia be removed, the *deep fascia* of the thorax will be exposed. It is a thin aponeurotic layer which covers the Pectoralis major and sends many prolongations between its fasciculi. It is attached to the front of the sternum and to the clavicle, and is thin over the upper part of the Pectoralis major, but thicker in the space between the great pectoral and latissimus dorsi muscles, where it forms part of one base of the

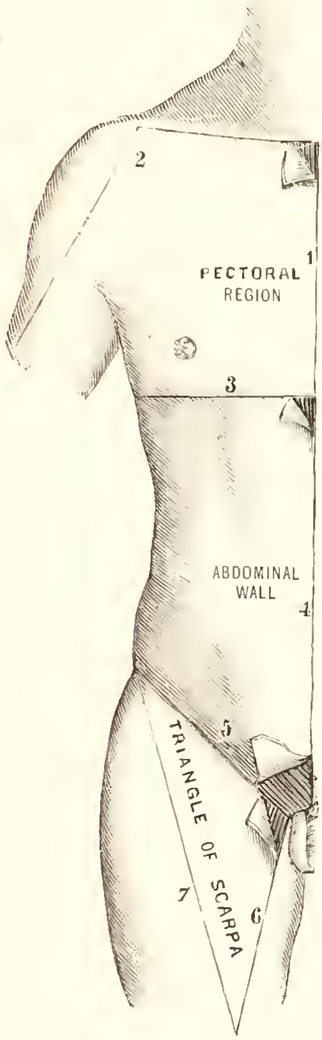


FIG. 25.—INCISIONS FOR DISSECTING THE PECTORAL REGION. RIGHT SIDE.

The numbers are placed opposite the various incisions.

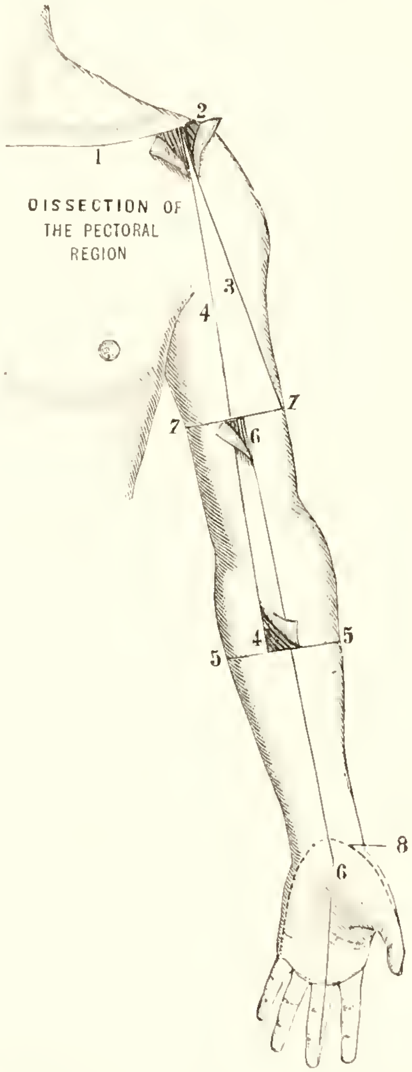


FIG. 26.—DIAGRAM OF INCISIONS IN DISSECTING THE PECTORAL REGION, ARM, FOREARM, AND HAND. LEFT SIDE.

axilla. At the outer margin of the latissimus dorsi it divides into two layers, one passing in front and the other behind it. These go on to be attached to the spinous processes of the dorsal vertebræ, blending with the fascia of the opposite side. At the lower and anterior part of the thorax this deep fascia is stronger, and is continuous with the sheath of the Rectus.

If an opening be made into it as it courses from the thorax to the arm,

and the finger be inserted, the dissector will form a better idea of its strength and connections.

Directions.—This fascia should be carefully removed, and the nerves which pierce it should be traced out. Small cutaneous vessels will guide to the position of these nerves.

Cutaneous Nerves.—These must be sought at the inner and upper

FIG. 27.—CUTANEOUS NERVES OF THE RIGHT UPPER LIMB. PALMAR ASPECT.

part of the thorax, and about the middle of the clavicle, and others may be found at the side of the sternum at each intercostal space. The lateral cutaneous thoracic nerves will be found about an inch below the anterior axillary fold, there being one for each intercostal space, the first excepted. These last-named nerves divide into an anterior and posterior branch.

The cutaneous nerves of this region come from the cervical plexus, or from the intercostal nerves.

Cervical Cutaneous Thoracic Nerves.—The *supra-clavicular* branches of the cervical plexus, which come from the third and fourth cervical nerve, emerge beneath the posterior border of the sterno-mastoid, and descend between it and the trapezius, to divide into sternal, clavicular and acromial branches, which supply the skin of the corresponding regions.

The *inner* or *sternal* branch passes obliquely inwards over the clavicular and sternal attachments of the sterno-mastoid, and supplies the skin as far as the midline, anastomosing with its fellow. It passes but a short distance down.

The *middle* or *clavicular* filaments, two or three in number, and of larger size, cross the centre of the clavicle and supply the skin over the deltoid and pectoral muscles to near the lower border of the latter, and communicate with cutaneous branches of the upper anterior intercostal nerves. Sometimes a clavicular branch passes through a foramen in the clavicle at the junction of the middle and outer thirds of the bone, and may join the anterior cutaneous branch of the second intercostal nerve.

The *external* or *acromial* branch will only now be seen in part. It crosses the outer surface of the trapezius and acromion, and goes to the skin of the upper and back part of the shoulder, anastomosing with the circumflex and supra-scapular nerves.

Cutaneous Intercostal Thoracic Nerves.—These are given off between the ribs from the trunks of the intercostal nerves, which latter are the anterior branches of the dorsal nerves. There are two sets of these cutaneous nerves. One set, the *lateral cutaneous* nerves of the thorax, arises from the intercostal trunks about midway between the spine and sternum; the other, the *anterior* set of thoracic cutaneous nerves, are the endings of the same intercostal trunks near the body midline. The intercostal nerves and their branches are distributed to the parietes and skin of the thorax, and upper part of the abdomen, without being joined in a plexus, differing in this important respect from other spinal nerves. Each nerve joins the sympathetic by one or two filaments, and they are divisible into an upper and lower set. The six upper, the first being excepted, supply the thoracic parietes; the six lower supply the lower part of the chest, and upper part of the abdomen.

The *Anterior Cutaneous Branches* of the intercostals pierce the pectorals and supply the skin at the side and forepart of the chest and that covering the mamma, and the upper digitations of the external oblique. The anterior cutaneous of the second intercostal joins the clavicular branch of the cervical plexus, and the others supply the mammary gland. Cutaneous branches of the internal mammary artery accompany these nerves, which latter increase in size as they pass downwards. The cutaneous twig of the second intercostal commonly lacks the anterior offset.

Lateral Cutaneous Nerves.—These pierce the external intercostals and serratus magnus midway between the vertebræ and sternum, accompanied by cutaneous vessels, and divide into two branches, anterior and posterior. The first intercostal nerve has not usually a lateral cutaneous branch. The *anterior* branches pass over the pectoral muscles to the mamma and skin and increase in size downwards the lower supplying the upper digita-

tions of the external oblique. The anterior cutaneous of the second intercostal commonly lacks the anterior offset. The *posterior* branches decrease from above downwards, and supply the skin over the latissimus dorsi and scapula. The lateral cutaneous branch of the second intercostal is larger than the others, and pierces the axillary fascia to supply the skin on the inner side of the arm, and is called the *intercosto-humeral nerve*. It is divided into two or more pieces as it crosses the axilla, and joins the nerve of Wrisberg, and piercing the deep fascia supplies the skin of the upper half of the inner and back part of the arm joining the internal cutaneous branch of the musculo-spiral. If the other cutaneous nerves,

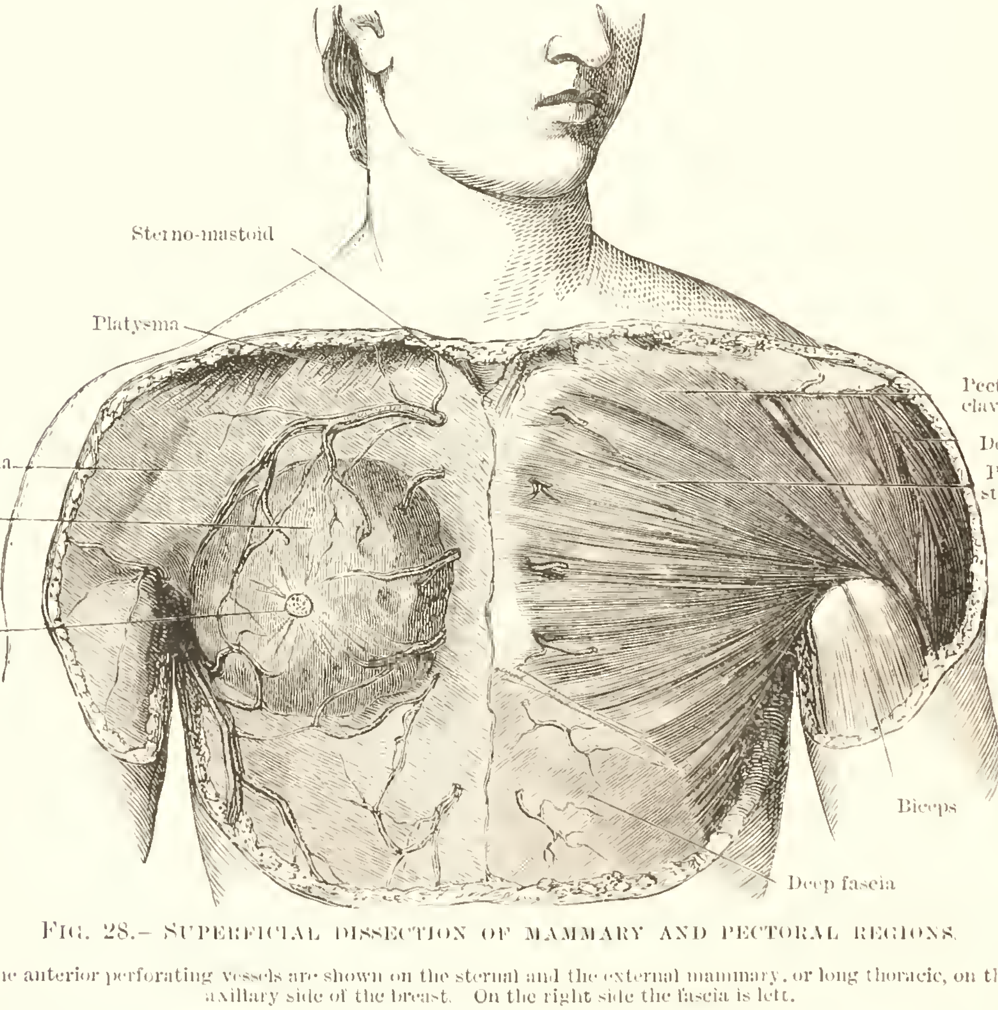


FIG. 28.—SUPERFICIAL DISSECTION OF MAMMARY AND PECTORAL REGIONS.

The anterior perforating vessels are shown on the sternal and the external mammary, or long thoracic, on the axillary side of the breast. On the right side the fascia is left.

the nerve of Wrisberg especially, be large, this nerve is small. A second intercosto-humeral nerve is often given off from the third intercostal, and it supplies the skin of the axilla and inner part of the arm.

Directions.—If the subject being dissected be a male the student must proceed to the examination of the axilla; but should it be a female, he should first examine the relations and connections of the mammary gland, then remove and dissect it.

The **Mammæ** are glands which secrete the milk, and are accessory to the reproductive system. A large class of animals (named mammalia) are distinguished by possessing these organs. They are enveloped in a

largish quantity of fat, and present two rounded prominences on each side of the front of the thorax. They are hemispherical, and more prominent at the inner and lower aspects, and extend from the third to the sixth or seventh rib, and from a little external to the sternum to the anterior axillary fold. Slightly below the centre of each breast, and on the level of the fourth rib, projects the *nipple* or *mammilla*, which is directed up and outwards. The surface of the nipple is darkish, and there is a coloured circle or *areola* around it, and the skin within this latter is of a darkish tinge. In the virgin these parts are pink, differing in depth of colour according to the individual's complexion; but in pregnant women or those who have borne children, or are menstruating, they are always darker. After lactation the dark colour subsides, but never completely vanishes. The nipple is about half an inch or more in length, and presents a shallow depression near its centre, where it is redder.

The skin of the nipple and areola is marked with wrinkles and covered with papillæ and lubricating glands. The nipple is perforated at its surface by numerous foramina, which are the openings of the *galactophorous*

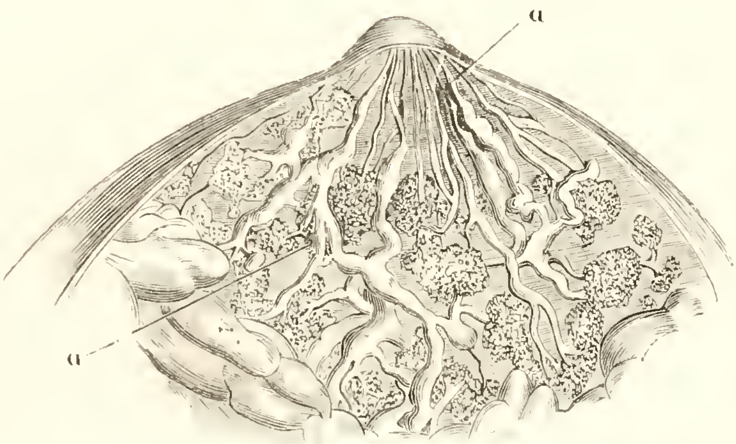


FIG. 29.—VERTICAL SECTION OF THE BREAST THROUGH THE NIPPLE TO NEAR ITS BASE.

a a. The lactiferous ducts with their dilatations and branched lobules between.

ducts; and on its surface are small tubercles, which are caused by the projections of minute glands having branched ducts, four or five of which open on each elevation. The tissue of the nipple is highly vascular, and contains unstriped muscular fibre, and its papillæ are very sensitive, irritation of it causing contraction of the muscular fibres which surround the base, and of some radiating fibres which run from the base to the apex of the nipple, and induce it to become firmer and project.

The base of the mamma is oval, slightly concave and flattened, and extends longitudinally from the third to the sixth or seventh rib, and transversely from the side of the sternum to the axilla. Its longest diameter is directed up and out towards the axilla. It is about an inch and half thick, its thickest part being near the centre opposite the nipple. It weighs from six to eight ounces. Its width, if not enlarged by suckling, is usually about four inches. It is embedded in connective tissue and fat, and rests on the pectoralis major, from which it is separated by a strong

layer of areolar tissue, which is continuous with the deep fascia. On its surface and passing between its lobes is a considerable quantity of fat, which gives the smooth round or oval form to the gland. This fat is of a bright yellow, and of firm consistence, and subdivided into lobules by septa of connective tissue. The nipple and areola are devoid of fat, as also is the finer structure of the gland.

Structure.—The mammæ resemble those glands which are constituted by the fascicular terminations of branched ducts. They consist of many distinct lobes and lobules held together by strong intervening connective and fatty tissue penetrating between them. Each lobe has an excretory or *lactiferous* duct and is subdivided into smaller lobes, and these again into smaller and smaller lobules, which are connected by areolar tissue, blood-vessels, lymphatics, and ducts.

The lobules are of a pale red creamy colour and are composed mainly of the vascular dilatations of the lactiferous ducts, which look like clusters of minute round vesicles about the size of a pin-hole, and having a diameter

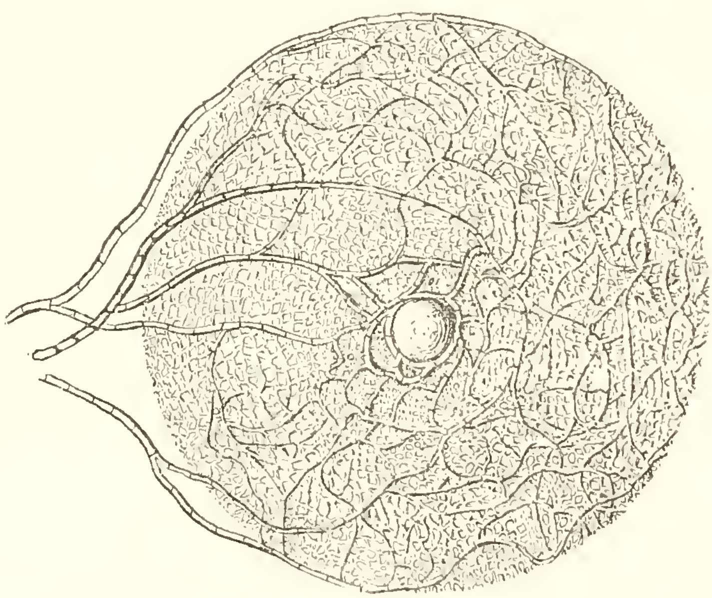


FIG. 30.—SHOWING THE LYMPHATIC VESSELS AND PLEXUSES OF THE RIGHT BREAST.

The large trunks to the left margin end with axillary glands.

from ten to thirty times as large as the closest capillary network which surrounds them. A number of the vesicles around their duct form the glandule or lobule, which may vary in size from a pin's head to a small oat seed. The lobes are formed by the union of the lobules, and are about twenty in number, each having a distinct galactophorous duct. These latter are from fifteen to twenty in number and converge to the areola, beneath which they have oblong dilatations (or *reservoirs, ampullæ, sinuses,* or *sacculi*) from one-sixth to one-third of an inch in width. At the base of the nipple these become reduced in size, approximate each other, the central ones being the largest, and then pass side by side, surrounded by connective tissue and vessels, through the nipple to its summit, nearly parallel with each other and without inter-communication, and, narrowing, gradually open on the apex of the nipple by separate orifices of the

size of a hair bristle to that of an ordinary pin. These openings are placed in little depressions and are smaller than their respective ducts.

Although this description be rather minute, the dissector may verify it by the ordinary dissecting means at his command and the use of a common magnifying glass. He may inject some of the ducts by means of a hypodermic syringe prior to dissection.

In the male this gland and all its parts are present but in a rudimentary state, the gland measuring usually only six to nine lines across and two lines thick. Sometimes the male mamma in young subjects enlarges and secretes a thin watery fluid, and in rare instances it has formed milk. The nipple is small and is surrounded by an areola which is studded with hairs.

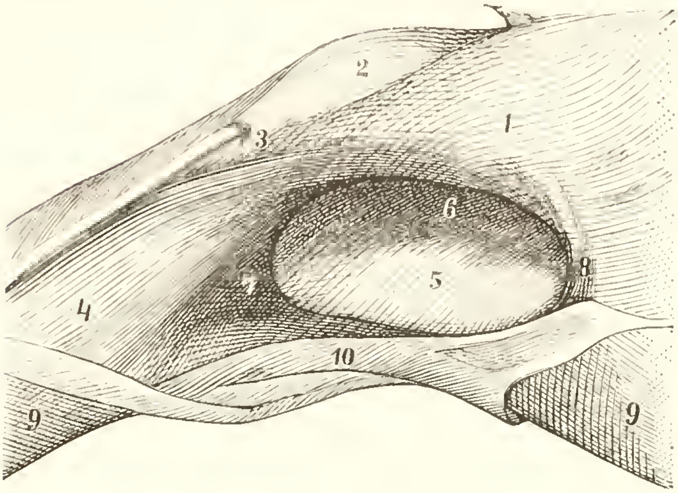
Blood-Vessels and Nerves.—The arteries of the breast come from the long thoracic, axillary, internal mammary and subjacent intercostals. The veins end in the axillary and internal mammary trunks, and some in the intercostal veins. Haller described a venous circle around the base of the nipple, and called it the *Circulus venosus.* This becomes distended in menstruation, pregnancy and lactation. The *lymphatics* of the outer side of the gland enter the axillary lymphatic glands, and those on the inner side debouch into the anterior mediastinal glands. The nerves come from the anterior and lateral cutaneous branches of the third, fourth and fifth intercostals.

Varieties.—There may be two or three nipples on one mamma, and there may be supernumerary mammæ. In rare cases four or five additional breasts have been observed. These supernumerary glands are most frequently placed near the ordinary pair, but sometimes they are in the axilla, on the thigh, back, groin or abdomen. The mamma sometimes enlarges to an enormous extent, and I have seen an instance in the Middlesex Hospital, under the late Mr. De Morgan, in which both reached below the knees. The subject was a girl under twenty.

THE AXILLA.

Dissection.—Remove the fat and fascia from the pectoralis major, carrying the scalpel in the direction of its fibres from the thorax to the arm; remove the fatty tissue from the axilla, being careful of the many vessels, nerves and lymphatic vessels and glands in it. A good plan is to follow up a blood-vessel to the axillary artery or vein, and then remove the fascia from these large vessels and trace out their branches. The alar and long thoracic branches of the axillary artery run towards the thorax and nearer the anterior wall of the thorax. The circumflex and subscapular vessels and nerves are nearer the posterior boundary, where also are the lesser internal cutaneous nerve and the musculo-spiral, near the sheath of the axillary vessels. Close to the posterior aspect of the axillary vein is the lesser internal cutaneous or nerve of Wrisberg, which is joined by the intercosto-humeral, a branch of the second intercostal nerve. Define the large nerves of the brachial plexus and the posterior thoracic nerve, which lies on the serratus magnus, and is a branch of the brachial plexus given off above the clavicle. The *posterior* branches of the intercostal nerves will be seen crossing the axilla.

Boundaries.—The axilla is a doubly pyramidal space, placed between the side and upper part of the thorax and the inner side of the arm. The



1. Pectoral fascia.
2. Deltoid fascia.
3. Opening for cephalic vein.
4. Brachial fascia.
5. Axillary fascia.
6. Passage of the pectoral fascia into the costo-coracoid fascia.
7. Brachial arch.
8. Axillary arch.
9. Skin.
10. The same reflected.

FIG. 31.—DEEP AXILLARY FASCIA. RIGHT SIDE.

base of one pyramid or cone (the thoracico-humeral base) is formed by the skin and deep fascia passing from the chest to the arm between the pectoralis major in front, and the latissimus dorsi behind, the apex of which

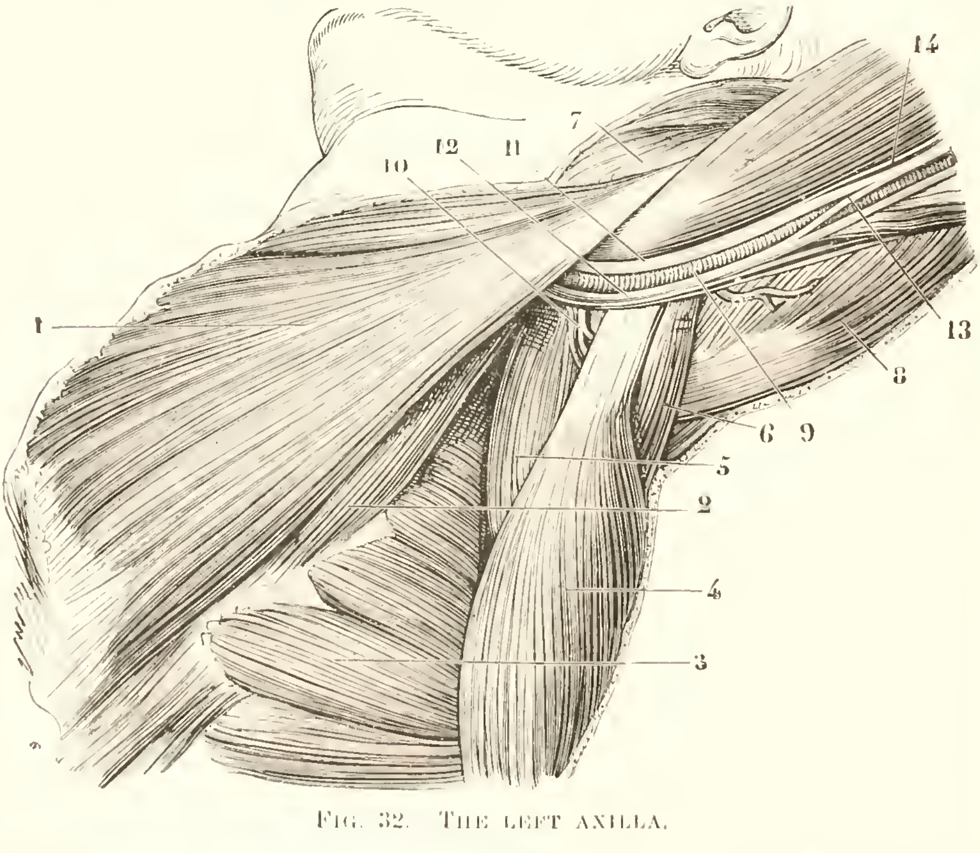


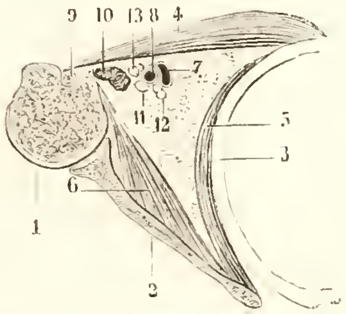
FIG. 32. THE LEFT AXILLA.

1. Pectoralis major.
2. Pectoralis minor.
3. Serratus magnus.
4. Latissimus dorsi.
5. Subscapularis.
6. Teres major.
7. Anterior part of deltoid.
8. Long head of triceps.
9. Axillary artery.
10. Circumflex vessels and nerve.
11. Outer head of median and external cutaneous arising together.
12. Inner head of median, ulnar, and internal cutaneous arising together.
13. Inner root of median.
14. External cutaneous.

is upwards at the root of the neck, and corresponds to the space between the two scalene muscles on the first rib; or to that between the clavicle, the upper margin of the scapula and the first rib. The base of the second pyramid (thoracic base) is at the chest wall, and the apex at the humerus between the pectoralis major and the latissimus dorsi. The anterior wall is formed by the pectoralis major over its whole extent and the pectoralis minor over its central portion. The posterior limit, which extends lower and reaches further out than the anterior, is formed from above downwards by the subscapularis, teres major and latissimus dorsi muscles. It is bounded internally by the first four ribs with the intervening intercostals, covered by their fascia and the upper part of the serratus magnus; and externally the space is narrow because the anterior and posterior boundaries converge. It is limited by the coraco-brachialis, biceps and humerus.

Contents.—The axilla contains the axillary vessels and their branches, the brachial plexus of nerves and its branches, branches of the intercostal nerves, lymphatic vessels and glands, and a large quantity of loose connective tissue and fat.

Relative Position of Vessels and Nerves.—The axillary artery and vein and brachial plexus pass obliquely along the outer boundary of the space, and much nearer the anterior than the posterior wall, the vein being



1. Upper end of humerus.
2. Scapula.
3. Ribs.
4. Pectoralis major.
5. Serratus magnus.
6. Subscapularis.
7. Axillary vein.
8. Axillary artery.
9. Tendon of long head of biceps in the bicipital groove.
10. Short head of biceps and coraco-brachialis.
11, 12, and 13. Median, musculo-spiral, and musculo-cutaneous nerves.

FIG. 33.—DIAGRAMMATIC ANTERO-POSTERIOR SECTION THROUGH THE LEFT AXILLA JUST ABOVE ITS THORACICO-HUMERAL BASE.

lower than, and on the thoracic side of, the artery. At the anterior part of the space, very close to the pectoral muscles, are the thoracic branches of the artery, especially the long thoracic, and parallel with it, though nearer the middle of the axilla, are the external mammary artery and vein. Along the posterior boundary in contact with the lower margin of the subscapularis are the subscapular vessels and nerves; and winding round the lower edge of this muscle are the dorsalis scapulæ artery and veins; and close to the humeral end of the muscle the posterior circumflex vessels and nerve curve back and out beneath the axillary vessels to the shoulder. On the thoracic or inner side only a few small branches of the superior thoracic are to be found; but the posterior thoracic or external respiratory nerve of Bell descends on the outer surface of the serratus magnus to supply it; and piercing the anterior superior part of this boundary, the lateral cutaneous or intercosto-humeral nerve, or nerves, pass across the axilla to the inner side of the arm.

There is a large quantity of loose connective tissue in the axilla, and a number of small arteries and veins, and several lymphatic glands with their intervening lymphatic vessels.

The *axillary lymphatic glands* are usually arranged in two sets, one

is situated on the thoracic side of the blood-vessels, and the other occupies the hinder and lower part of the space along the posterior boundary. The glands vary in number and size, but there are usually ten or twelve with small blood-vessels from the branches of the axillary vessels to them.

The glands at the side of the blood-vessels receive the lymphatics of the arm, but the lymphatics of the posterior surface of the back, from the forepart of the thorax and the outer portion of the mamma, empty themselves into the glands along the hinder boundary of the axilla. Most of the efferent ducts from these glands join to form a trunk which empties itself into the lymphatic duct of the same size at the root of the neck, but some may separately empty into the subclavian vein.

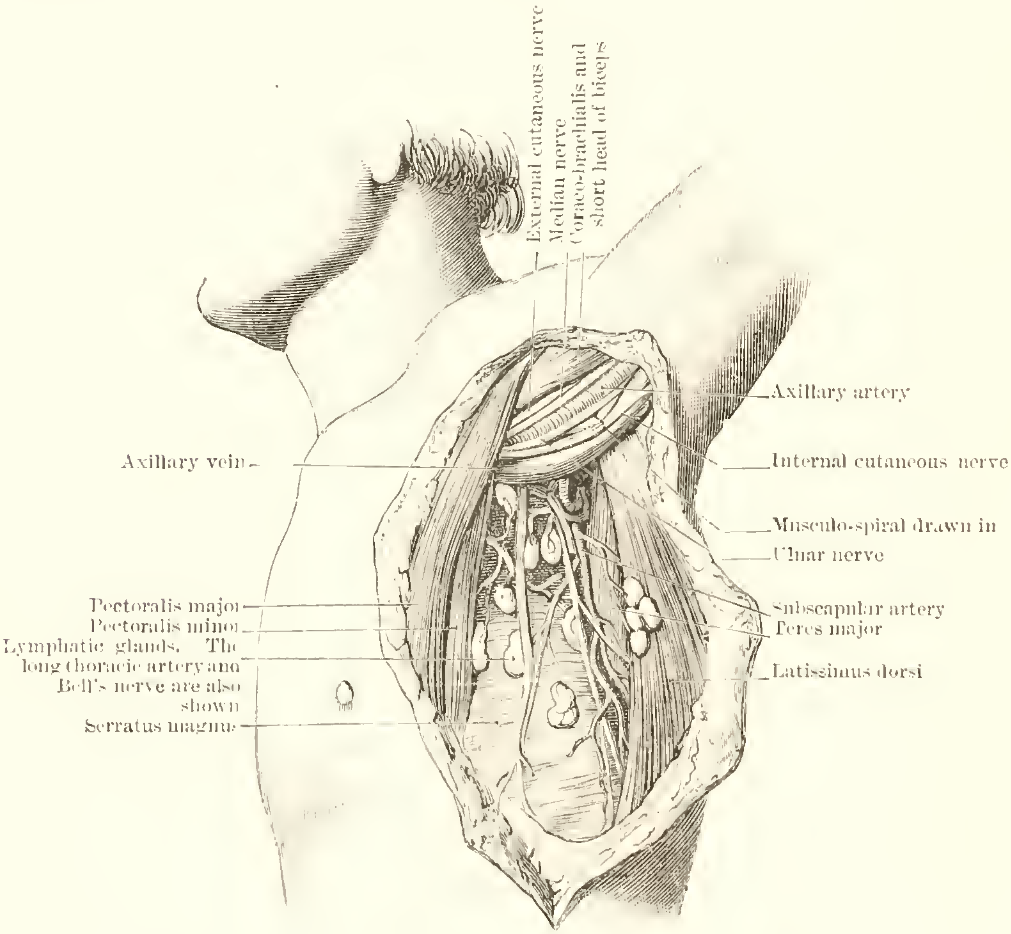
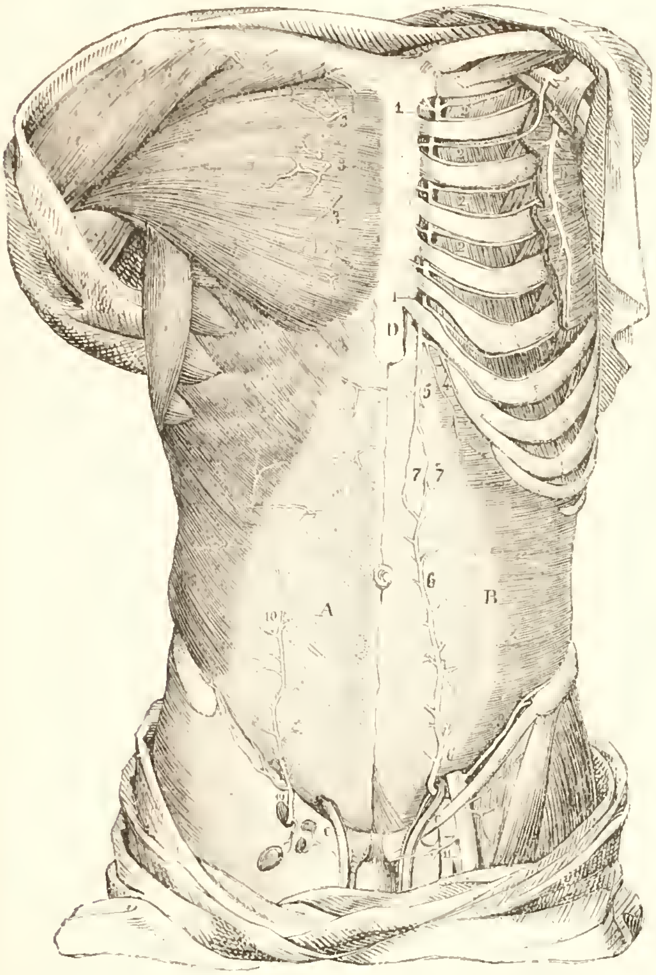


FIG. 31.—RELATIONS OF STRUCTURES IN THE LEFT AXILLA.

Surgical Anatomy.—The dissector should attentively study the relations of the important vessels and nerves in this space, because there is frequent need of surgical interference in this region. The third part of the axillary artery may have to be secured, or the nerves may have to be cut down upon and stretched. Tumours may have to be extirpated in this region, and the lymphatic glands are frequently removed when they are enlarged either during or after the operation of extirpation of the breast for cancer or sarcoma. The third part of the axillary artery may have to be compressed by the fingers (digital compression), or by a tourniquet, in amputation through the arm high up, and by knowing the position and relations of the vessels, the best and easiest mode in which it may be com-

pressed will be obvious to the student. Esmarch's elastic bandage cannot well be used in amputation through the arm very high up.

The **Pectoralis Major** is a triangular broad, thick muscle placed at the upper and anterior part of the thorax, and in front of the axilla. Its base is at the chest, and its apex at the humerus. It arises by aponeurotic fibres,



1. Int. mammary.
2. Intercostal arteries.
3. Perforating.
4. Ext. branch of mammary.
5. Int. ,, ,,
6. Epigastric.
7. Anast. with int. mammary.
8. Long thoracic.
9. Circumflex iliac.
10. Superficial epigastric.
11. ,, pudic. The serratus magnus has been cut away on the left of the figure to show the intercostal muscles and arteries.

FIG. 35.—SHOWING ORIGIN OF PECTORALIS MAJOR ON THE RIGHT OF FIGURE, AND OF THE SUBCLAVIUS ON THE LEFT, AND THE ANASTOMOSES BETWEEN THE INTERNAL MAMMARY AND EPIGASTRIC ARTERIES.

which intersect those of the opposite muscle, from the cartilages of all the true ribs, the first or seventh, or both, being excepted; from the aponeurosis of the external oblique, from half the breadth of the anterior surface of the sternum as far as the cartilage of the sixth or seventh rib, and from the anterior surface of the sternal half of the clavicle. The fibres rotate and converge to its insertion. The clavicular fibres pass down and out, and are generally separated from the rest by a small interval; those from the lower end of the sternum and lower costal cartilages pass up and out beneath the former, whilst the middle fibres pass horizontally out. These three sets of fibres overlap each other, the upper overriding the middle, and the middle the lower. The fibres of the lower portion are folded back upon themselves, so that those fibres which are lowest in front are highest at their insertion. These various fibres end in a flat tendon about two inches broad, which is inserted into the anterior bicipital ridge of the

humerus. The tendon is bilaminate, one lamina being in front of the other, and these are usually blended below. The anterior lamina is the thicker, and receives the clavicular and upper half of the sternal part of the muscle. The posterior lamina receives the lower half of the sternal portion. From this disposition it occurs that the fibres of the upper and middle portions are inserted into the lower part of the bicipital ridge, while those of the lower portion are attached to its upper part. At its insertion this tendon is connected with that of the deltoid, and it sends up an expansion along the bicipital groove towards the head of the humerus, which often blends with and strengthens the capsule of the shoulder joint. Another expansion passes down and back, lining the bicipital groove, and yet another is given off to the deep fascia of the arm.

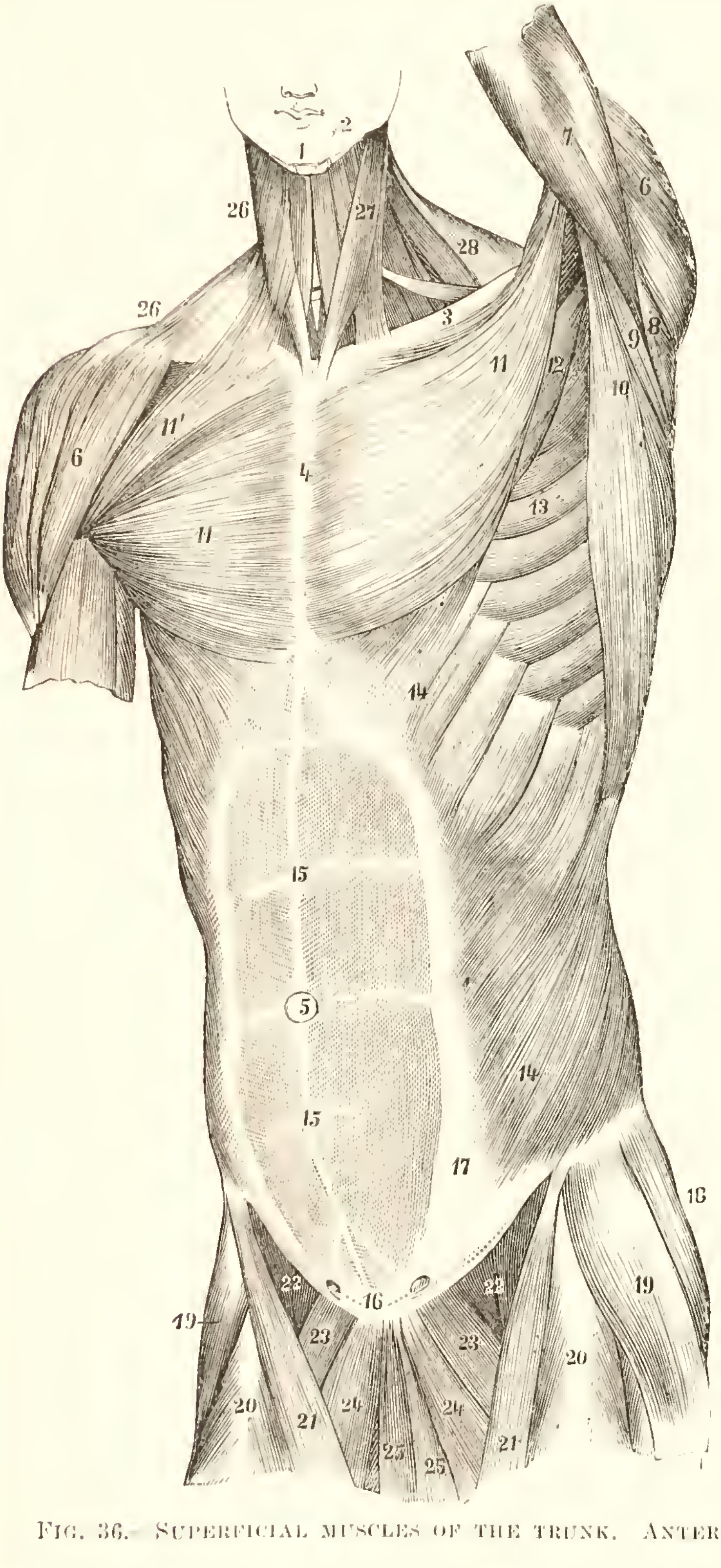
Actions.—It is an adductor and internal rotator of the arm, and can move the limb forwards until the elbow is in front of the trunk. The clavicular fibres will assist in raising as well as adducting the arm. The middle horizontal fibres will simply adduct, and the lower sternal and costal fibres will adduct and depress. If the arm have been raised, the pectoralis major, acting with the latissimus dorsi and teres major, will bring it down. Taking its fixed point from the humerus, it will act as an extraordinary muscle of inspiration raising the ribs, as may be seen in persons suffering from dyspnœa.

Nerves.—External and internal anterior thoracic and filaments from the intercostals.

Varieties.—These consist usually, in a less or greater extent, of its attachments in muscular subjects. The origins of the two muscles are separated by a narrow interval, but in ill-developed bodies there is a large interspace. The clavicular part may be absent or completely blended with the deltoid. In rare instances the whole sternal portion is wanting. Sometimes additional muscular slips pass from the aponeurosis of the external oblique to the lower margin of the pectoralis. Sometimes muscular slips connect it with the biceps or with the latissimus dorsi (muscular arches). Occasionally a slender slip, parallel with the outer margin of the sternum and overlapping its origin, is present. It is attached above to the upper part of the sternum near the sternal origin of the sterno-mastoid, and below it is connected to the sheath of the rectus. This slip is named the *Rectus sternalis*. A muscular band passing from a fascial origin from some of the lower true and upper false ribs to a variable aponeurotic or tendinous insertion, somewhere along the inner border of the arm, or even as low as the inner humeral condyle, is sometimes found, and is called the *Chondro-* or *Costo-Epitrochlearis*. There may also be a great gap between the clavicular and sternal portions. Rarely a supernumerary fasciculus from the fascia covering the serratus passes to the lower border of the muscle, and equally rare is a deep supernumerary fasciculus which passes from the second or third costal cartilage or neighbouring part of the sternum to the deep layer of the deltoid sheath. Occasionally its tendon receives a small muscular fasciculus from the internal intermuscular aponeurosis, and sometimes fasciculi are given off from its inferior border which pass with the pectoralis minor to be attached to the coracoid process, or pass down to the flexor muscles of the arm. Its tendon sometimes gives a separate expansion to the lesser tuberosity.

Dissection, and Relations of the Pectoralis Major.—Divide the

pectoralis major along its clavicular attachments, being careful of the vessels and nerves which enter its under surface. Cut through its sternal



1. Chin.
2. Hyoid bone.
3. Clavicle.
4. Sternum.
5. Umbilicus.
6. Deltoid.
7. Triceps.
8. Teres minor.
9. Teres major.
10. Lat. dorsi.
11. Pect. maj.
12. Pect. min.
13. Serratus mag.
14. Ext. oblique.
15. Linea alba.
16. Ext. inguinal ring.
17. Aponeurosis of ext. oblique.
18. Gluteus medius.
19. Tensor fasciæ latæ.
20. Rectus femoris.
21. Sartorius.
22. Ilio-psoas. Poupart's lig. between 16 and 22.
23. Pectineus.
24. Add. long.
25. Gracilis.
26. Platysma myoides.
27. Sterno-cleido-mastoid.
28. Trapezius.

FIG. 36. SUPERFICIAL MUSCLES OF THE TRUNK. ANTERIOR VIEW, ONE-FIFTH.

part about three or four inches from the sternum, and reflect it inwards and outwards. Remove the fat and fascia, passing from the upper border

of the pectoralis minor to the clavicle, and expose the costo-coracoid membrane. The cephalic vein, the anterior thoracic nerves, and the acromial thoracic artery which pierce this membrane will now be seen. The tendon of insertion and any of its expansions should now be examined, and the two ends for a moment replaced to study its relations.

Relations.— In relation with its *anterior surface* are the skin, superficial fascia, and fat, lower part of the platysma, and the mamma. Its *posterior surface* has the following relations (parts covered by the pectoralis major): near the thorax are the sternal ribs and costal cartilages, the pectoralis minor, serratus magnus, and intercostals, and near the axilla it is

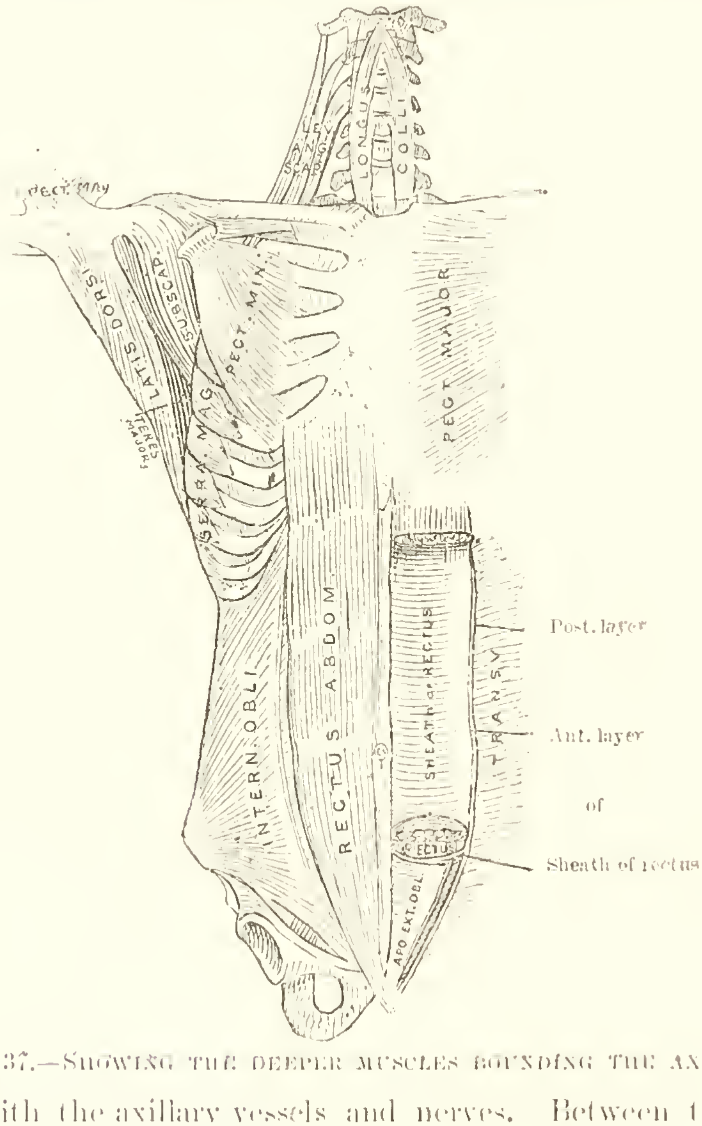


FIG. 37.—SHOWING THE DEEPER MUSCLES BOUNDING THE AXILLA.

in relation with the axillary vessels and nerves. Between the pectoralis minor and clavicle it conceals the subclavius muscle, the axillary vessels in their sheath, the branches piercing the sheath, and the anterior thoracic nerves. Below the pectoralis minor its folded *lower border* forms the anterior margin of the axilla, and near the humerus it rests on the biceps and coraco-brachialis muscles. Its *upper border* is parallel with the anterior border of the deltoid, separated by a slight interval which widens towards the clavicle in which run up the cephalic vein, and the humeral branch of the acromio-thoracic artery runs down.

The **Pectoralis Minor** is triangular, with its apex at the coracoid process, and base at the thorax. It passes obliquely up and out, crossing diagonally beneath the Pectoralis major. It arises by three tendinous digitations from the upper margins and outer surfaces of the third, fourth, and fifth ribs external to their cartilages, and from the aponeurosis covering the corresponding intercostals. The fibres pass up and out to a flat tendon which is inserted into the anterior border and anterior half of the upper surface of the coracoid process of the scapula, blending with the short head of the biceps and coraco-brachialis.

Relations.—In *front* of it are the pectoralis major and the superior thoracic vessels and nerves; *behind* it are the third, fourth, and fifth ribs, and corresponding intercostals, some digitations of the serratus magnus, the axilla, and the axillary vessels and nerves. Its *upper border* is separated from the clavicle by a triangular space (infra-clavicular space or triangle), the base of which is internal and the apex at the coracoid process. The *lower border* near the thorax projects beyond the pectoralis major, and the long thoracic artery runs along it.

FIG. 38.—ANTERO-POSTERIOR SECTION OF THE CLAVICLE, PECTORALS, AND COSTO-CORACOID MEMBRANE, SEEN FROM THE SIDE (DIAGRAMMATIC).

Above is the clavicle with the subclavius beneath it; to the right is the pectoralis major and fascia covering it; to the left is the pectoralis minor and costo-coracoid ligament above it; and below is the skin and fascia of the axilla.

Action.—It draws the scapula forwards, downwards, and inwards, and the scapula being fixed, it raises the third, fourth, and fifth ribs.

Nerve.—Internal anterior thoracic.

The Costo-coracoid Membrane or *Ligament* is a strong piece of fascia, which is thicker externally at its coracoid attachment, but thinner internally, where it is connected with the lower border of the clavicle as far as the sternal end of the first rib. *Below* it is continuous with the fascia inclosing the pectoralis minor; *externally* it covers the axillary vessels and nerves, blending with the sheath of the vessels beneath the pectoralis minor, and then joins the deep fascia of the arm. It is attached *above*, between the rib and the coracoid process, to the lower border of the clavicle inclosing the subclavius. *Internally* it is of less extent than externally, as in the former position it passes but a short distance on the axillary vein. It is pierced by the cephalic vein, the acromio- and superior thoracic arteries and vein, and the external and internal anterior thoracic nerves.

Dissection.—Carefully cut through the costo-coracoid membrane near

the clavicle, and having dissected out the structures which pierce it, throw it downwards. The infra-clavicular space and its boundaries and contents will then be apparent.

The Infra-Clavicular Space or *Triangle* is bounded *above* by the clavicle, and *below* by the upper border of the pectoralis minor. Its base is at the outer margin of the sternum, and its apex at the coracoid process. It is covered in by the skin and superficial fascia, the upper part of the pectoralis major, and the costo-coracoid membrane. Its floor is formed by the anterior part of the first two intercostal muscles. It contains the first part of the axillary vessels in their sheath and the cords of the brachial plexus. In the very rare operation of tying the first part of the axillary artery, this space must be opened into.

Directions.—Raise the lower border of the subclavius, and trace the fascia inclosing it to its attachment, then clean the sheath of the axillary vessels and nerves.

The *Sheath of the Axillary Vessels and Nerves* is a continuation of the deep cervical fascia, being a prolongation from the fascia on the scalene muscles. It resembles in shape and function the funicular membranous tube surrounding the upper part of the femoral vessels. It is a loose sheath, strengthened near the clavicle by the costo-coracoid membrane. Its anterior part is perforated by the same structures which pierce the costo-coracoid fascial band.

The **Subclavius** is a long spindle-shaped muscle between the first rib and clavicle. It arises by a short thick tendon from the anterior part of the cartilage of the first rib in front of the rhomboid or costo-clavicular ligament. Its fibres pass obliquely up and out, and are inserted into a deep groove on the under-surface of the middle third of the clavicle between the internal and external tubercles which are for the attachment of the costo- and coraco-clavicular ligaments.

Relations.—By its *upper* surface with the clavicle; by its *under* with the end of the subclavian or commencement of the axillary vessels and brachial plexus of nerves. Its *anterior* surface is separated from the pectoralis major by the costo-coracoid membrane, which sends a process also behind it.

Action.—It depresses and draws forward the clavicle, and also the scapula indirectly; and if the clavicle be fixed it raises the first rib

Nerve.—It is supplied by a branch from the cord, which results from the junction of the fifth and sixth cervical nerves, and is given off above the clavicle, being situated in the subclavian triangle.

Varieties.—It sometimes has no clavicular attachment, being inserted into the root of the coracoid process; or it may have a double insertion, one into the clavicle and another into the coracoid process. When the former condition exists it may be called the *costo-coracoid* muscle.

Dissection.—Carefully remove the sheath of the axillary vessels and the remains of the costo-coracoid membrane, and clean the axillary vessels and nerves.

The **Axillary Artery** is the continuation of the subclavian, and extends from the lower border of the first rib to the lower border of the latissimus dorsi and teres major muscles, where it becomes the *brachial.* In the axilla its position will be indicated by a line from the middle of the clavicle to the inner edge of the coraco-brachialis, but its direction varies with the position of the limb; for when the arm is pendent, it forms a curve whose

convexity is up and out; when the arm forms a right angle with the side of the chest, it is almost straight; but when the limb is much raised, the artery forms a curve whose concavity is upwards. Its first two parts are deeply placed; but it is quite superficial at its termination.

For convenience of description it has been divided into three parts the first being *above* the pectoralis minor, the second *behind* or *beneath* and the third *below* or *beyond* that muscle.

Relations of the First Part.—In *front* are the costo-coracoid membrane and structures piercing it, the subclavius, the clavicular part of the pectoralis major, and the cephalic vein. *Behind* it are the first intercostal space and first corresponding intercostal muscle, the first serration of the serratus magnus, and the posterior thoracic nerve. On its outer or acromial side are two cords of the brachial plexus separated by a small cellular interval. On its inner or thoracic side is the axillary vein.

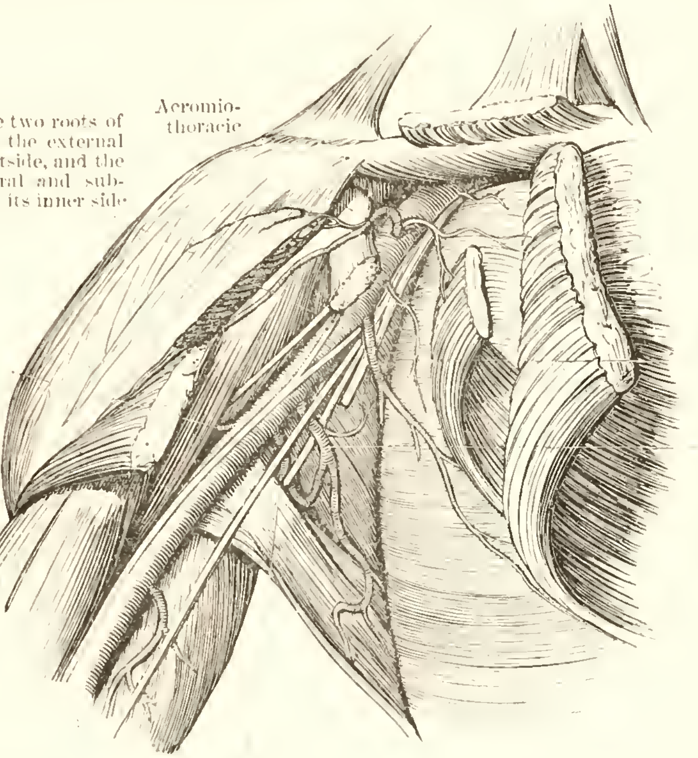


FIG. 39.—RIGHT AXILLARY ARTERY AND ITS BRANCHES, THE PECTORALS REFLECTED.

RELATIONS OF FIRST PART OF AXILLARY ARTERY.

In front.—Skin and superficial fatty layer, clavicular part of pectoralis major, costo-coracoid membrane, subclavius, cephalic vein, and anterior thoracic nerves.

Outside.—Brachial plexus. Two cords.	Axillary Artery	*Inside.*—Axillary vein.

Behind.—First intercostal muscle and space, first serration of serratus magnus, and the posterior thoracic nerve.

Relations of the Second Part.—It is covered in *front* by the pectoralis major and minor; *behind* it is separated by a cellular space from the subscapularis and posterior nerve cord; on the *inner* side is the axillary vein. The brachial plexus surrounds this part of the vessel and separates it from the vein and neighbouring vessels, the outer cord being external, the inner internal, and the middle behind the vessel.

RELATIONS OF SECOND PART OF AXILLARY ARTERY.

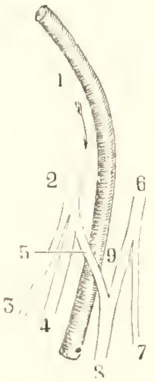
In front.—Skin and fascia, and pectoralis major and minor.

Outside.—Outer cord.

Axillary Artery

Inside.—Inner cord, axillary vein, internal anterior thoracic nerve.

Behind.—Subscapularis and posterior cord of the brachial plexus.



1. Axillary artery.
2. Inner cord.
3. Internal cutaneous.
4. Ulnar.
5 and 9. Outer and inner heads of median nerve.
6. Outer cord.
7. External cutaneous.
8. The median.

FIG. 40.—RELATIONS OF LEFT AXILLARY ARTERY TO NERVES (DIAGRAMMATIC).

Relations of the Third Part.—Beyond the pectoralis minor it is in relation in *front and above* with the lower part of the pectoralis major, but below this only with the skin and fascia and internal cutaneous nerve. *Behind* it are the lower part of the subscapularis and the tendons of the latissimus dorsi and teres major, and the median and musculo-spiral nerves. On its *outer* side are the coraco-brachialis and median and musculo-spiral nerves, and at its *inner* side are the axillary vein, ulnar and internal cutaneous nerves.

RELATIONS OF THIRD PART OF AXILLARY ARTERY.

In front.—Skin and fascia and pectoralis major and internal cutaneous nerve.

Outside. — Coraco-brachialis and median and musculo-spiral nerves.

Axillary Artery

Inside.—Axillary vein, and ulnar and internal cutaneous nerves.

Behind.—Subscapularis, tendons of latissimus dorsi and teres major, musculo-spiral and circumflex nerves.

The vessel is here surrounded by the large trunks into which the brachial plexus is broken up. External to it is the median and the musculo-cutaneous for a short distance. On the inner side are the ulnar, the internal cutaneous and lesser internal cutaneous. The internal cutaneous is also superficial to the artery. *Behind* it are the musculo-spiral and circumflex nerves, the latter going only to the lower border of the subscapularis.

Varieties.—The most important peculiarity in a practical sense is the giving off of a large branch from the trunk. This occurs once in ten subjects. In some cases this large branch is the radial (1 in 33); in others it is the ulnar (1 in 72); and very rarely it is the interosseous (1 in 506, R. Quain). In some subjects this large branch gives origin to the subscapular, two circumflex and superior and inferior profundæ; but sometimes only one circumflex and profunda come from it. In these cases the brachial plexus usually surrounds the trunk from which the branches come, and not the main vessel. A *vas aberrans* is sometimes given off from the brachial and joins one of the branches of the axillary.

Surgical Anatomy.—In the removal of tumours or in amputation of the arm high up, the third part of the vessel must be compressed by

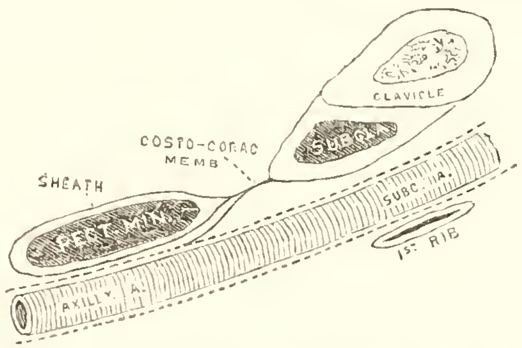


FIG. 11.—DIAGRAM OF COSTO-CORACOID MEMBRANE AND SHEATH OF AXILLARY ARTERY. LEFT SIDE.

Altered from Cunningham.

directing the pressure from within outwards against the humerus. In aneurism of the brachial the third part may be tied, or a distal ligature may be applied to it in aneurism of the third part of the subclavian or higher parts of the axillary. The second and third parts have been tied, but it is a safer practice to ligate the third part of the subclavian in cases requiring it. If the vessel be wounded it must be secured above and below the wound, being careful of the surrounding structures, and compressing the third part of the subclavian; but these cases are usually fatal before the surgeon sees them.

Collateral Circulation.—If the first part be tied between the superior and acromio-thoracic, the circulation will be maintained by the same branches as after ligature of the third part of the subclavian, and then will be described with that vessel; but if it be secured between the acromio-thoracic and subscapular, the latter by its free anastomoses with the scapular branches of the subclavian will be the main means in maintaining the circulation of the upper limb. If the long thoracic be below the ligature, it will materially assist in consequence of its anastomoses with

the internal mammary and intercostals. If the ligature be below the subscapular, the anastomoses between the posterior circumflex and the acromio-thoracic and suprascapular, and those between the subscapular and superior profunda, will aid in restoring the circulation, which is, however, less free through these channels.

Dissection.—After tracing out the branches of the axillary vessels, which should now be done, the pectoralis minor must be divided near its insertion and reflected, noting the nerves which pierce and supply it. Then the axillary vessels must be cut just below the second rib and thrown aside, and the strong fascia investing the nerves must be carefully removed, so that the branches of the brachial plexus may be made out.

Branches of the Axillary Artery.– These are distributed to the thoracic wall and shoulder. Four of them are named *thoracic* (superior,

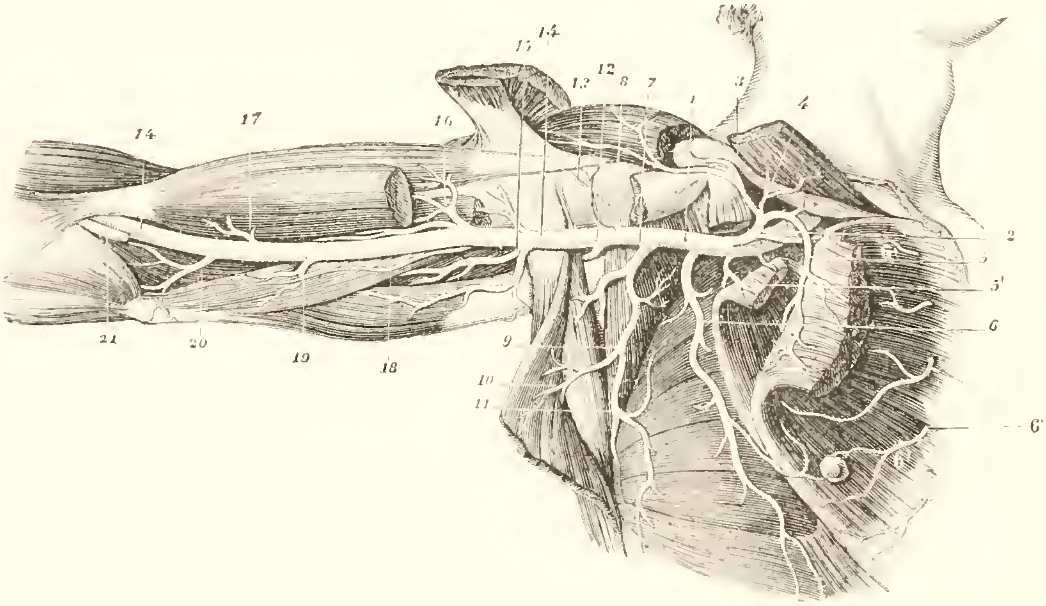


FIG. 42. BRANCHES OF THE RIGHT AXILLARY AND BRACHIAL ARTERIES.

1. Axillary.
2. Acromio-thoracic.
3. Acromial branch of 2.
4. A muscular branch of 2.
5. Thoracic branch of 2.
5'. Alar or posterior thoracic.
6. Long thoracic.
6'. Anterior perforating of internal mammary.
7. Subscapular.
8. Dorsalis scapulæ.
9. Continuation of subscapulars.
10 and 11. Musculars of subscapular.
12. Posterior circumflex.
13. Anterior circumflex.
14. Brachial.
15. Superior profunda.
16, 17, 18. Muscular.
19. Inferior profunda.
20. Anastomotica magna.
21. Median nerve cut.

The pectorals, biceps, coraco-brachialis, and latissimus dorsi are cut and reflected.

acromial, long and alar thoracic). The superior and acromial thoracic are given off from the front of the vessel above the pectoralis minor. The alar thoracic is given off beneath it, and the long thoracic at the lower border. The three branches to the shoulder are subscapular and two circumflex, and in the female there is often an external mammary artery and vein near the middle of the axilla. When present it supplies the axillary lymphatic glands and ends in the thoracic wall below the long thoracic. The branches are usually given off thus: two from the first part, the superior and acromio-thoracic; two from the second portion, the alar and long thoracic; and three from the third, the subscapular and anterior and posterior circumflex.

The *Superior thoracic* is the highest and smallest offset, and is given off opposite the first intercostal space, either separately or by a trunk

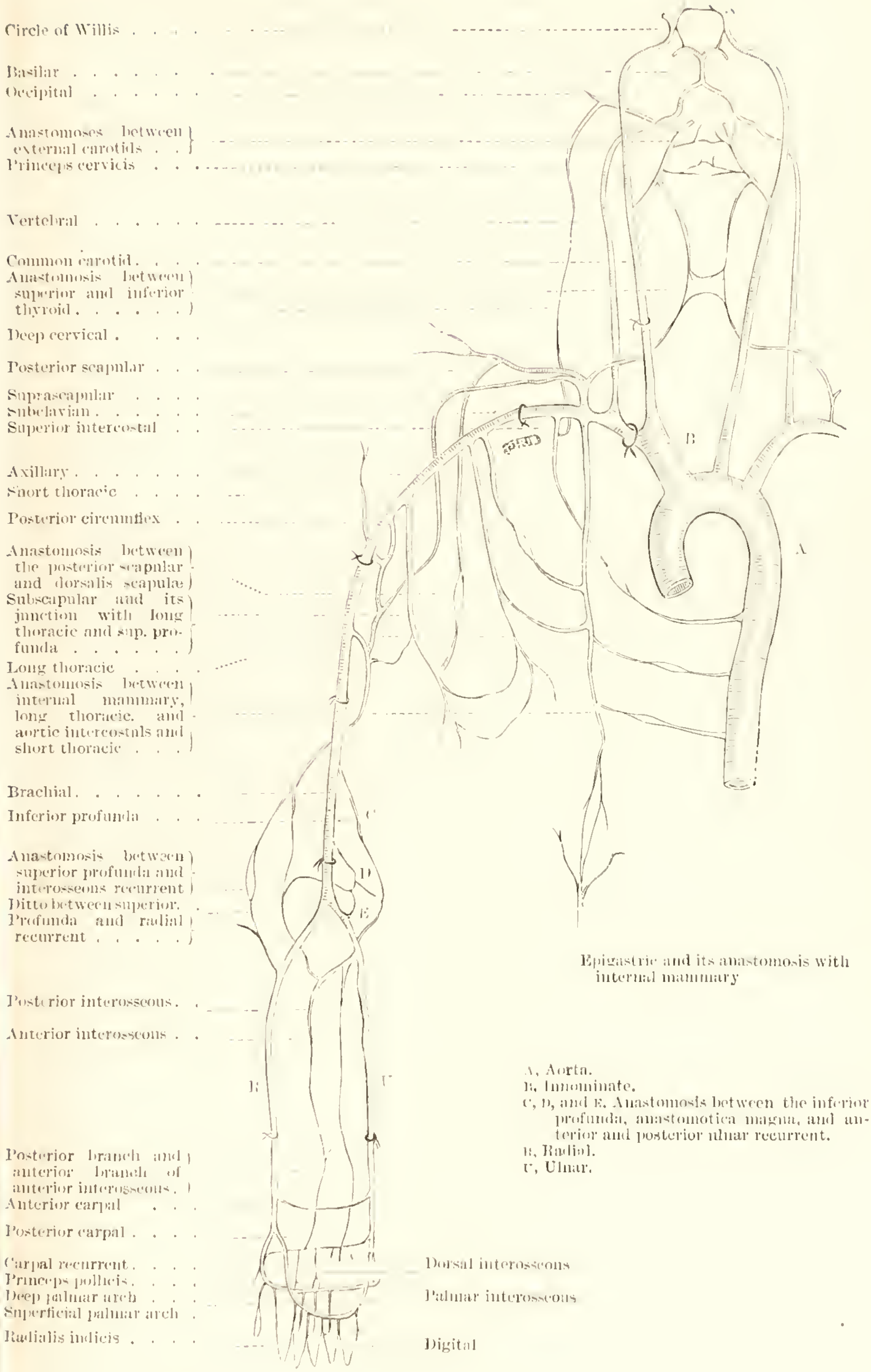


FIG. 13. DIAGRAM OF THE COLLATERAL CIRCULATION OF THE ARM.

Altered from Smith and Walsham.

common to it and the acromio-thoracic. It runs inwards along the upper border of the pectoralis minor and passes to the side of the chest between it and the major, supplying them and anastomosing with the intercostal and internal mammary arteries. This vessel is so commonly a branch of the acromio-thoracic that it has been described as the ordinary condition, the common trunk being called the *thoracic axis.*

The *Acromio-thoracic* is a short trunk from the front of the vessel, and is seen at the upper border of the pectoralis minor, and between the pectoralis major and deltoid. It divides into three sets of branches, which pass respectively *inwards*, *upwards*, and *outwards*. It has been called the *thoracic axis*. The *inner* or *thoracic* set are two or three, and supply the serratus magnus and pectorals, and anastomose with the anterior intercostal branches of the internal mammary and the other thoracic vessels. The *outer* or *acromial* set are mainly destined for the deltoid.

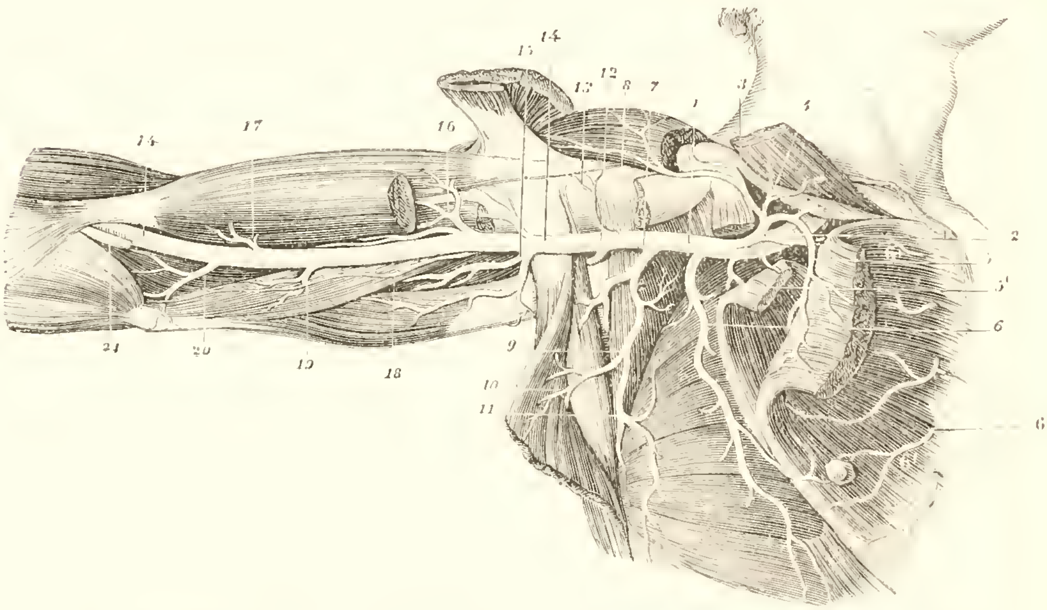


FIG. 41.—BRANCHES OF THE RIGHT AXILLARY AND BRACHIAL ARTERIES.

1. Axillary.
2. Acromio-thoracic.
3. Acromial branch of 2.
4. A muscular branch of 2.
5. Thoracic branch of 2.
5'. Alar or posterior thoracic. Long thoracic.
6'. Anterior perforating of internal mammary.
7. Subscapular.
8. Dorsalis scapulæ.
9. Continuation of subscapulars.
10 and 11. Musculars of subscapular.
12. Posterior circumflex.
13. Anterior circumflex.
14. Brachial.
15. Superior profunda.
16, 17, 18. Muscular.
19. Inferior profunda.
20. Anastomotica magna.
21. Median nerve cut.

The pectorals, biceps, coraco-brachialis, and latissimus dorsi are cut and reflected.

One small vessel accompanies the cephalic vein for a short distance between the pectoralis major and deltoid, supplying them, and another, called the *inferior acromial*, pierces the deltoid and anastomoses on the acromion with the supra-scapular and posterior circumflex arteries. One or two small vessels pass up to the subclavius and deltoid muscles.

The Alar Thoracic is a small and inconstant vessel which supplies the glands and cellular tissue of the axilla. It is frequently substituted by branches from the other thoracic vessels, or from the subscapular.

The *Long Thoracic* passes along the lower border of the pectoralis minor to near the sixth intercostal space, supplying the serratus magnus, the pectorals and mamma, and sending branches across the axilla to the

axillary glands and subscapularis. It anastomoses with the intercostal internal mammary and the other thoracic vessels.

Varieties.—This vessel often comes from the acromio-thoracic or the subscapular, or enlargement of the normal branches of the acromio-thoracic replaces it.

The **Subscapular** is the largest branch of the axillary, and is given off opposite the lower edge of the subscapularis, and passes down and back along its lower margin to the inferior scapular angle, where it anastomoses with the posterior scapular from the subclavian. It gives branches to the subscapularis, latissimus dorsi, teres major, serratus magnus and axillary glands; and rather more than an inch from its origin a large branch, the *dorsalis scapulæ*, is given off from it, but this vessel sometimes is given off directly from the axillary. This bends round the lower border of the scapula, quitting the space between the teres minor above, the teres major below, and the long head of the triceps in front. Before passing to the back of the scapula the dorsalis scapulæ gives off the *infra-scapular*, which passes beneath the subscapularis to the posterior aspect of the scapula, supplying both these structures and anastomosing with the posterior and supra-scapular arteries. The continuation of the dorsalis scapulæ enters the infra-spinous fossa and anastomoses with the supra- and posterior scapular arteries. A third or *median* branch runs along the axillary border of the scapula between the teres major and minor, and anastomoses with the infra- and posterior scapular on the dorsum of the inferior scapular angle. The long subscapular nerve accompanies the subscapular artery, the dorsal branch of which latter sometimes comes directly from the axillary.

The **Circumflex** branches are two, *anterior* and *posterior*, and wind round the neck of the humerus. The *posterior* is much the larger, and is given off from the back of the axillary opposite the lower border of the subscapularis, and passes backwards with its accompanying veins and the circumflex nerve through a quadrangular space, bounded above by the teres minor, below by the teres major, outside by the humerus, and inside by the long head of the triceps, and winding round the humeral neck ramifies in the deltoid, supplying it and the shoulder joint, and anastomosing with the anterior circumflex, suprascapular, and acromial thoracic. The termination of this vessel will be subsequently dissected. It cannot now be made out.

Varieties.—The *posterior circumflex* is occasionally given off from the superior profunda branch of the brachial. It then ascends behind the tendons of the latissimus dorsi and teres major. Less frequently it gives off one or more branches, which are usually derived from other sources; thus, it may come from the anterior circumflex, the superior profunda, the dorsalis scapulæ, or the superior profunda and anterior circumflex together. It is sometimes double.

The *Anterior Circumflex*, much smaller than the posterior, is given off from the outer side of the axillary just below the posterior circumflex. It passes forwards and outwards beneath the coraco-brachialis and short head of the biceps on the fore part of the humeral neck to the bicipital groove, where it divides into two branches: one ascends along the groove to nourish the head of the bone and the shoulder joint; the other passes out and back beneath the deltoid, supplying it and anastomosing with the

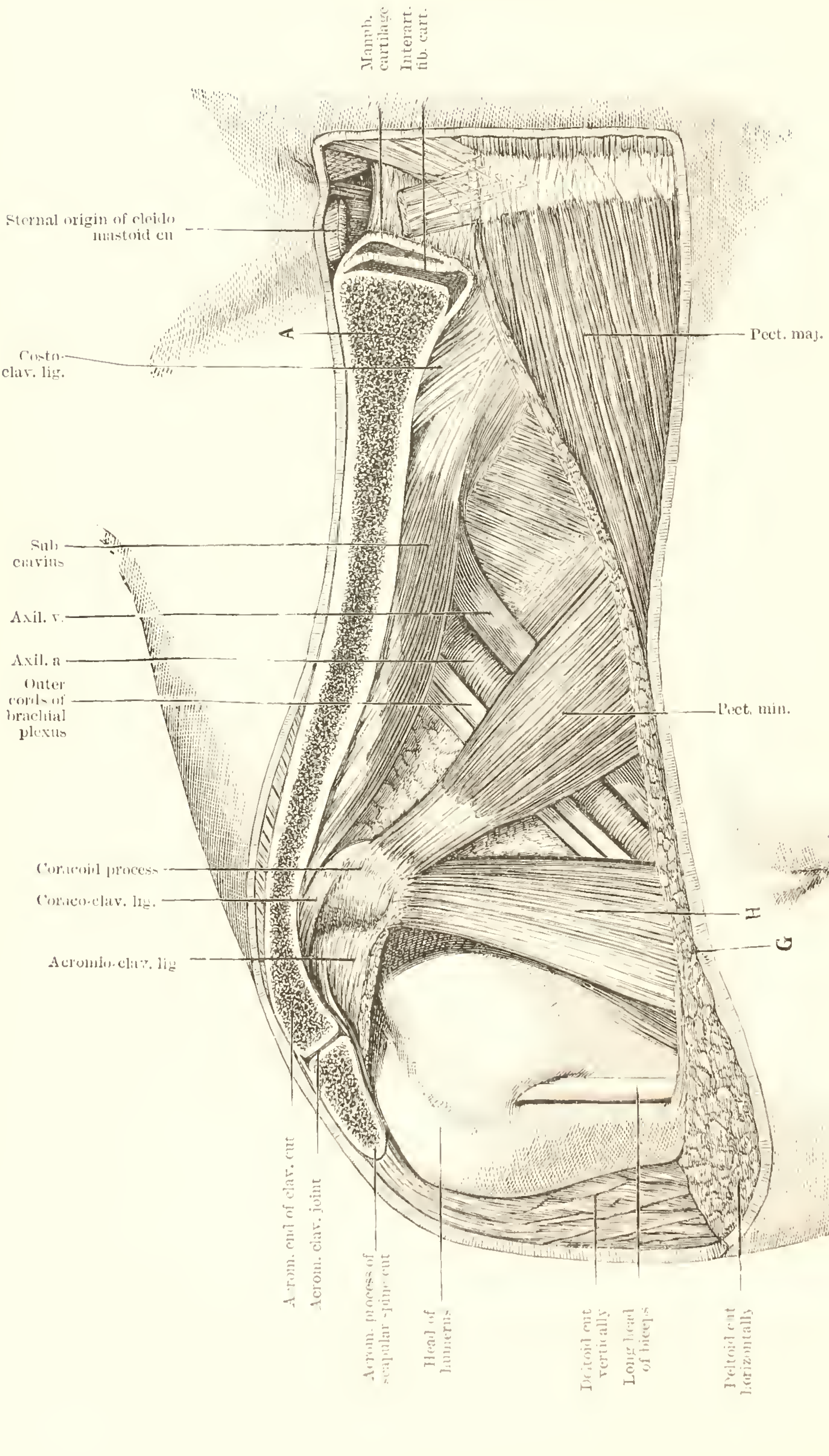


FIG. 15.—VERTICAL TRANSVERSE SECTION THROUGH THE RIGHT CLAVICLE, AND DEEP DISSECTION OF PECTORAL REGION.

A. Clavicle. G. Line where deltoid and pect. major meet. H. Coraco-brachialis and short head of biceps. The sterno-hyoid origin is seen beneath the sterno-mastoid. The first external intercostal is to the inner side of axillary vein. On either side of the tendon of the pectoralis minor the axillary fat is represented. The first intercostal is shown.

posterior circumflex and acromial thoracic. This vessel is sometimes double, but not so frequently as the posterior.

The **Axillary Vein** is a large vessel, having the same extent and rela-

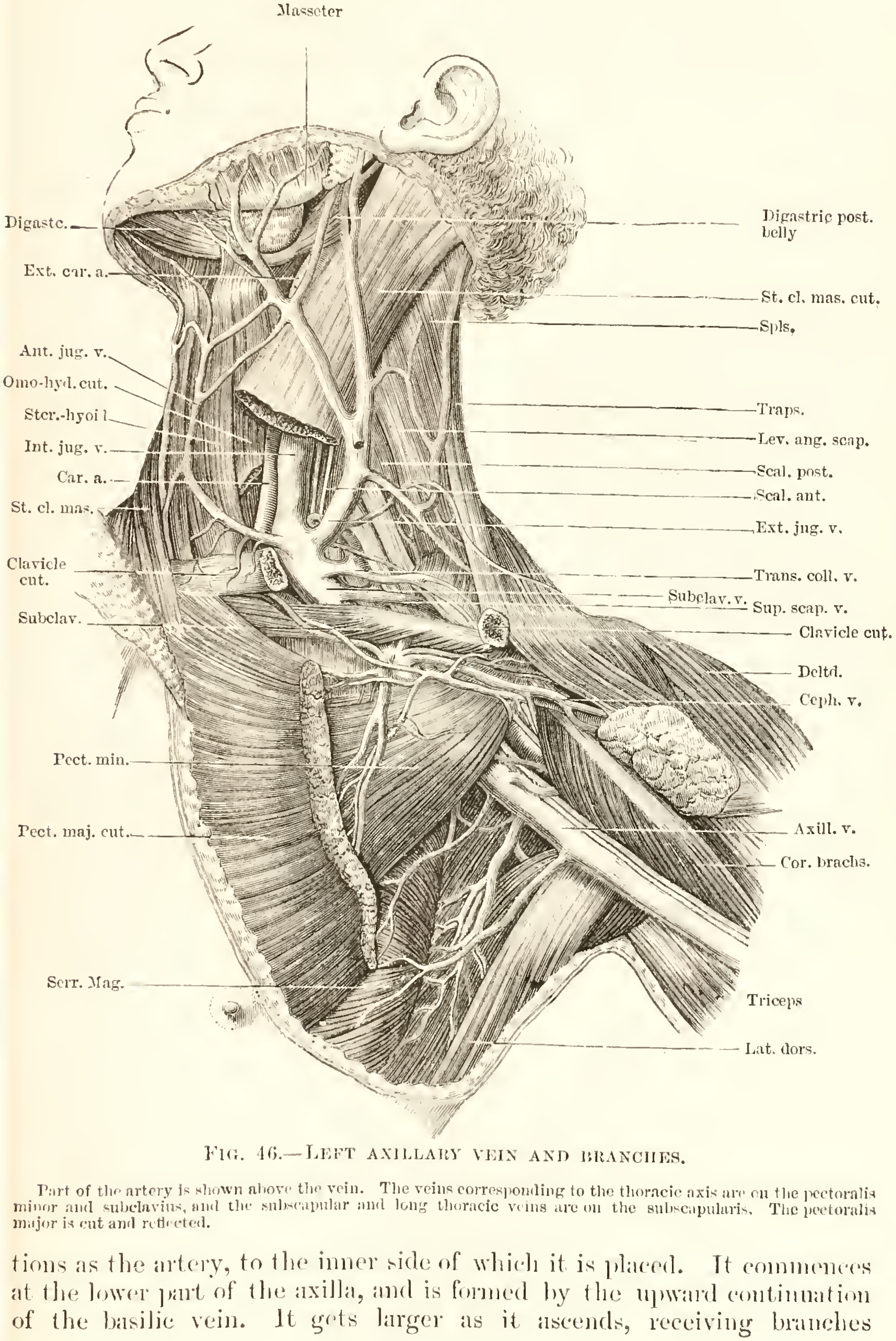


FIG. 46.—LEFT AXILLARY VEIN AND BRANCHES.

Part of the artery is shown above the vein. The veins corresponding to the thoracic axis are on the pectoralis minor and subclavius, and the subscapular and long thoracic veins are on the subscapularis. The pectoralis major is cut and reflected.

tions as the artery, to the inner side of which it is placed. It commences at the lower part of the axilla, and is formed by the upward continuation of the basilic vein. It gets larger as it ascends, receiving branches

corresponding to those of the artery, also the venæ comites of the brachial opposite the subscapularis, and the cephalic near its termination. It has a pair of valves opposite the lower border of the subscapularis, and valves where the subscapular and cephalic vein debouch into it. It is continued upwards into the subclavian vein. It anastomoses with the superficial veins of the neck and thorax and abdomen, and also with the femoral vein.

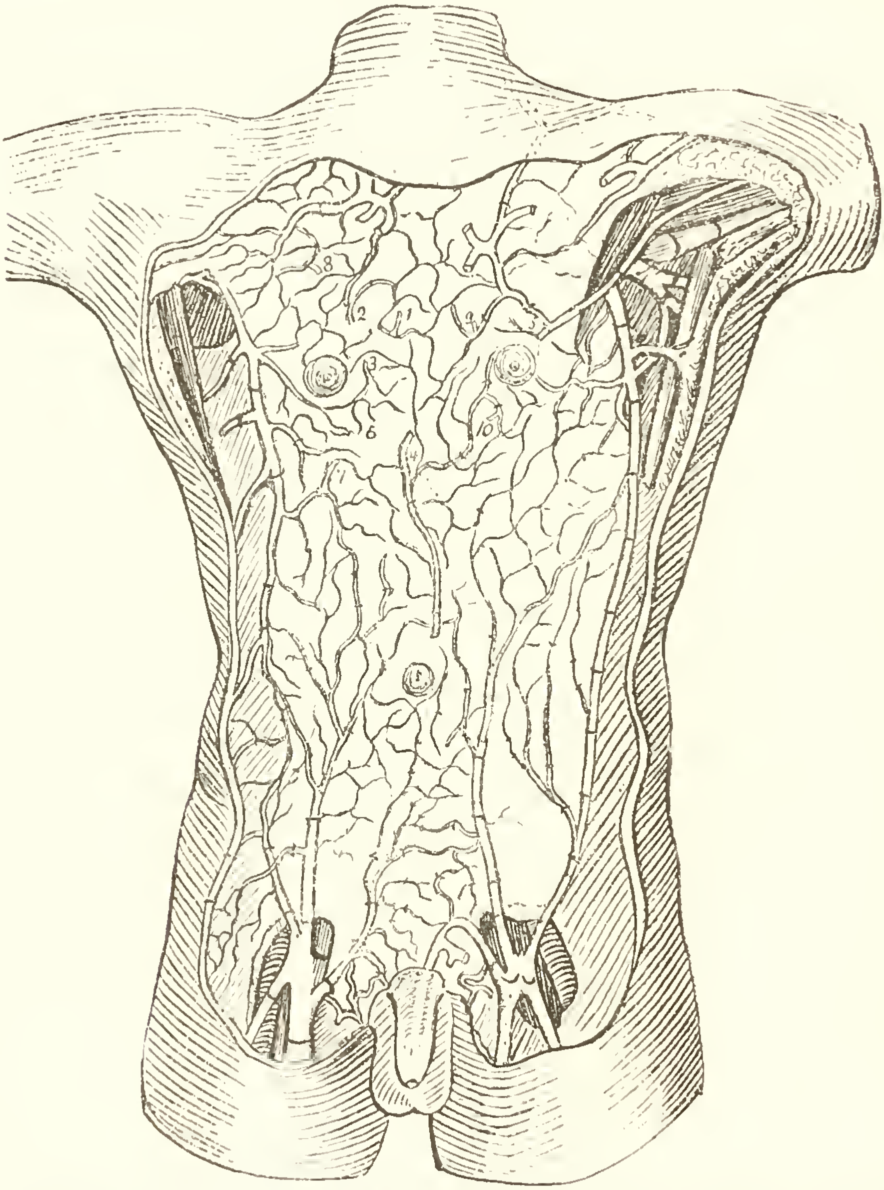


Fig. 47.—Dissection showing the anastomoses of the axillary and femoral veins with the superficial abdominal veins, and of these (at the places numbered) with the deeper abdominal and thoracic veins. The transverse lines indicate the position of the valves. I have shown in dotted outline the junction of the upper veins with the cervical veins on the left.

From Mr. E. Hurry Fenwick's exhibits at the recent International Medical Congress.

Varieties.—It is rare to find an anomaly in the trunk of the vein, but one or two veins corresponding to the branches of the artery may enter into the subscapular, basilic, or circumflex veins, instead of into it. I once saw two large axillary veins which united to form the subclavian, and I

have seen it on two or three occasions, and once while operating in the axilla, rather behind than internal to the artery.

The **Brachial Plexus.**—This large plexus, which furnishes the nerves of the upper limb, is formed by the junction of the *anterior trunks* of the four lower cervical and greater part of the first dorsal nerves, receiving a fasciculus from the fourth cervical. It extends from the lower part of the neck to the axilla, and opposite the coracoid process it divides into large nerves for the arm and forearm. The part below the clavicle must now be dissected, and it will be seen that its relations are similar to those of the artery.

The disposition of the nerves forming this plexus is liable to variation.

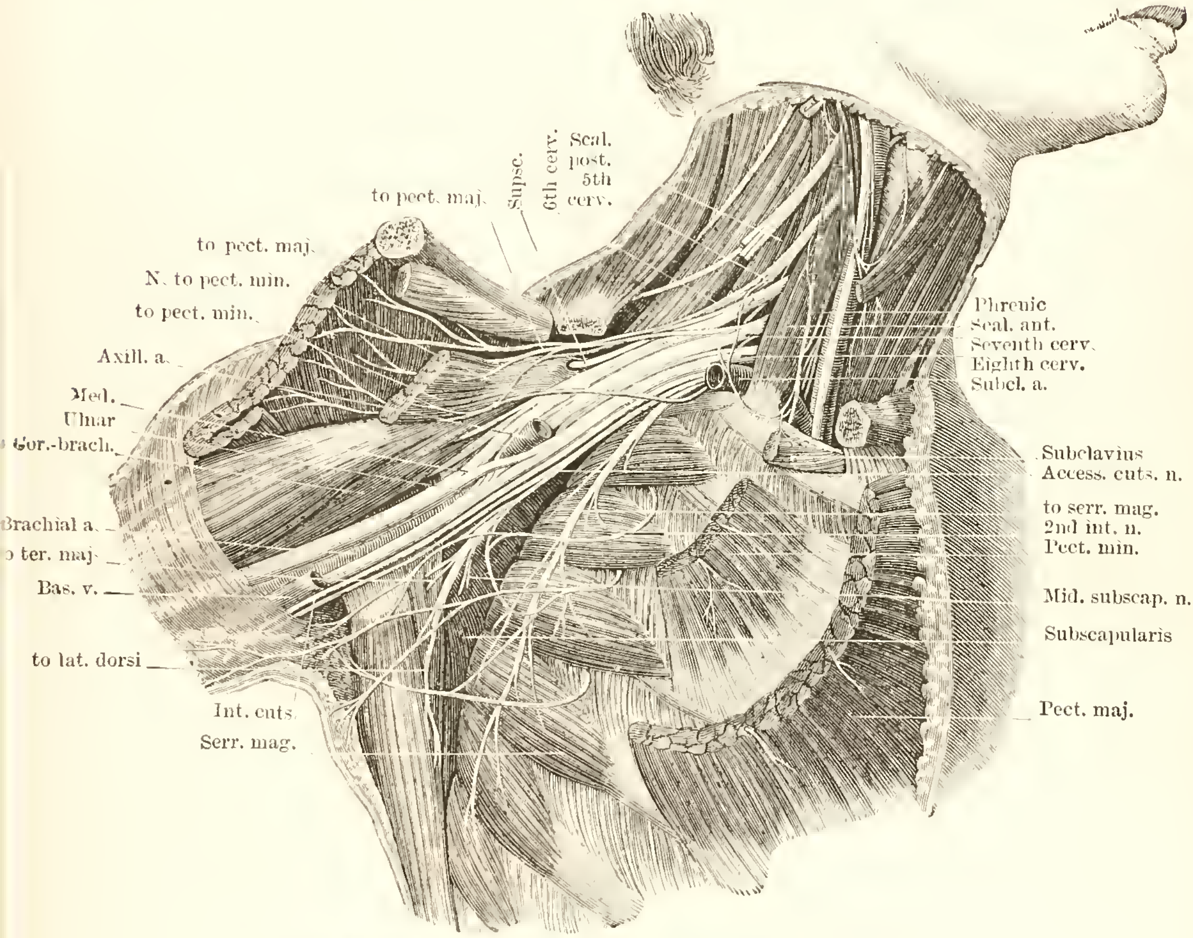


FIG. 48.—DISSECTION OF RIGHT BRACHIAL PLEXUS.

The most frequent arrangement is the following:—The fasciculus, from the 4th, 5th, and 6th cervical, unite at the outer border of the scalenus medius and form an *upper* or *outer trunk*; the 7th cervical remains single and forms the *middle* or *posterior trunk*; and the 8th cervical and part of the 1st dorsal join between the scalenes to form a *lower* or *inner trunk*.

Just external to the scalenus medius each *primary trunk* divides to form an anterior and posterior branch. The *anterior branches* of the outer and middle trunks join to form the *upper* or *outer cord*. The *anterior branch* of the lower trunk itself forms the *lower* or *inner cord*, and the

posterior branches of all three trunks join to form the *middle* or *posterior cord*. These cords are external to the first part of the axillary artery, and lie aside each other in the anterior part of the plexus, but lower down they are arranged thus: the outer cord is external to the artery, the inner internal, and the middle behind, and they are then continued into the principal nerves of the limb.

Another arrangement commonly met with is, that instead of three there are only *two primary* trunks which lie on the outer side of the artery; the one nearer the vessel is formed by the eighth cervical and part of the first dorsal; and the other by the fasciculus from the fourth, and

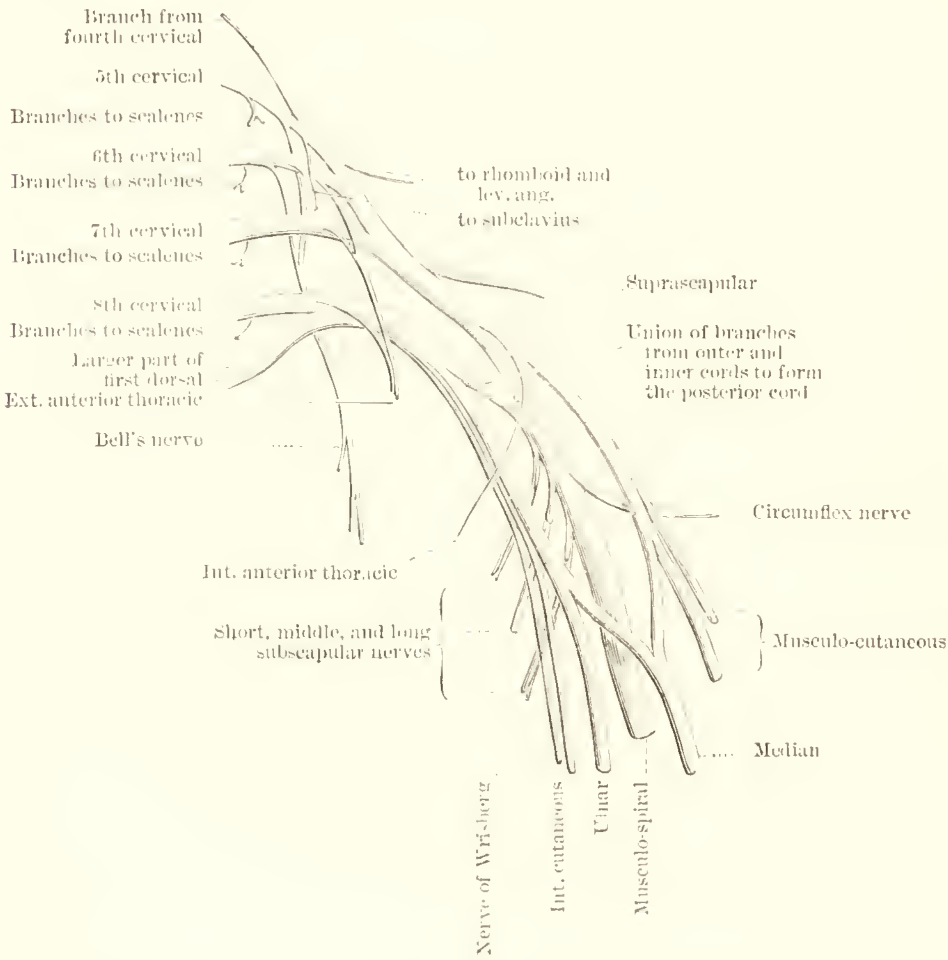


FIG. 49.—DIAGRAM OF LEFT BRACHIAL PLEXUS, REPRESENTING THE SECOND DESCRIPTION OF THE TEXT. SEEN FROM THE FRONT.

The phrenic from the fourth and fifth is not shown.

the fifth, sixth, and seventh cervical nerves; the third or posterior cord being formed a little lower down by the union of two branches, one from each of the two primary trunks. The relation of the three cords to the vessels is usually the same in both arrangements.

Branches.—This plexus gives off branches above and below the clavicle. It is only with the latter that we have now to deal.

The *External Cord* gives off the external anterior thoracic, the external, or musculo-cutaneous, and the external root of the median.

The *Internal Cord* gives off the internal anterior thoracic, internal cutaneous, lesser internal cutaneous, or Wrisberg's nerve, internal root of median and ulnar.

The *Posterior Cord* gives off three subscapular (short, middle, and long), the circumflex and the musculo-spiral. The student will note that the branches of the external cord are all named *external*, and those of the internal, with the exception of the ulnar, all bear the prefix *internal*. This will assist him to remember the branches of the outer and inner cords and also of the posterior cord, which are indirectly known by not having the prefixes external or internal attached to them.

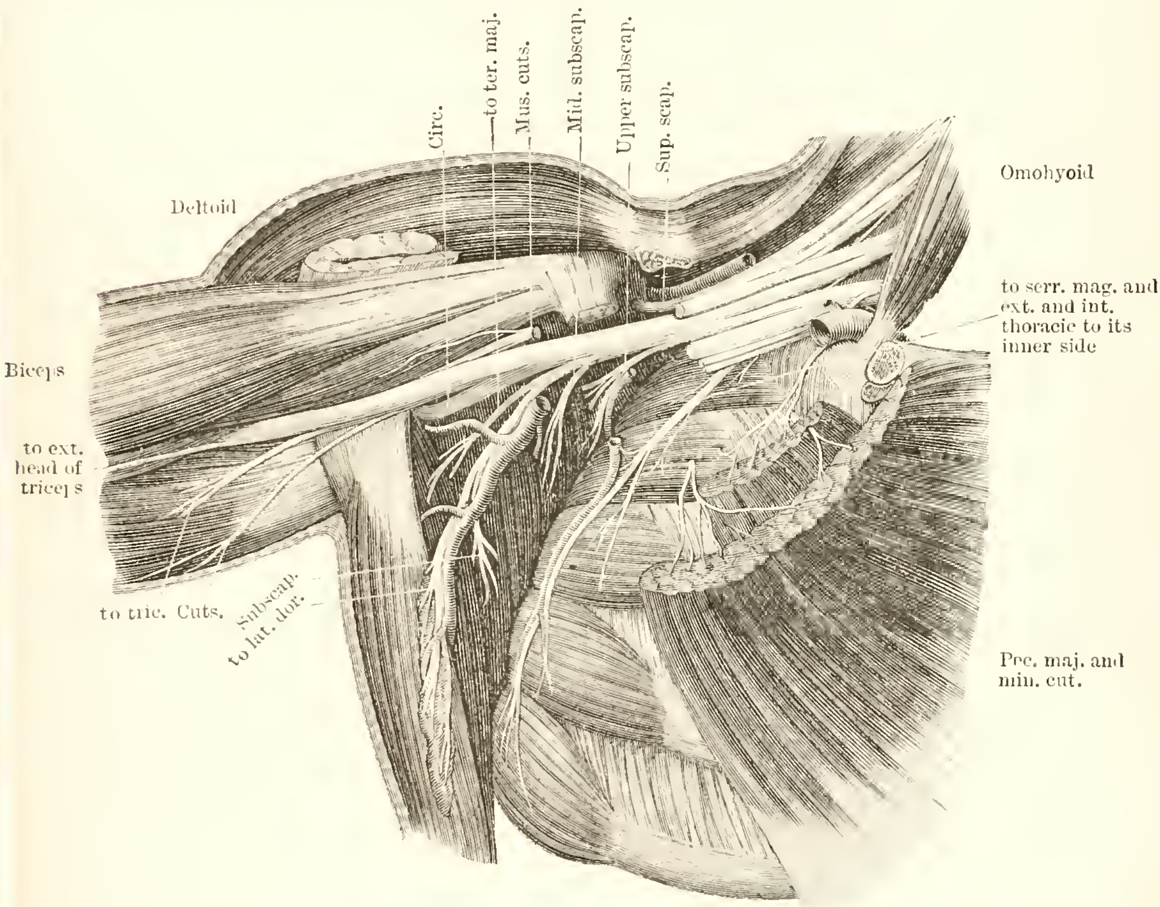


FIG. 50.—BRANCHES OF RIGHT POSTERIOR CORD, OUTER AND INNER CORDS CUT; ALSO THE AXILLARY ARTERY AND ITS BRANCHES.

This cord, after giving off the subscapular and circumflex nerves, is continued as the musculo-spiral. The outer and inner cords are cut.

Varieties.—The trunk formed by the fifth and sixth nerves often unites with the seventh at the outer border of the scalenus anticus, and thus only two instead of three trunks are found. Sometimes the branches which form the posterior cord are given off as low as the clavicle, but usually they arise at a higher level than do the two other cords. The fifth alone, or the sixth with it, often pierces the upper part of the anterior scalenus, and the former sometimes passes quite in front of this muscle.

Directions.—Each of these nerves must be traced to its origin, but the continuations of most of them cannot now be dissected.

The *External Anterior Thoracic Nerves* are two, outer and inner; the former is the more superficial and runs inwards over the axillary artery to supply the pectoralis major. On the inner side of the artery it joins the internal thoracic nerve.

The *Interior Anterior Thoracic* passes forwards between the artery and vein, receives the branch from the external thoracic, supplies the pectoralis minor and some of its filaments and pierces this muscle to enter the pectoralis major. It has a plexiform arrangement beneath the pectoralis minor.

The *Subscapular Nerves* come from the posterior cord, and are the short, middle, and long subscapular. The shortest and highest of these enters the upper part of the subscapularis. The middle subscapular gives a branch to the lower part of the subscapularis and ends in the teres major. Sometimes there is a separate nerve for the last-named muscle.

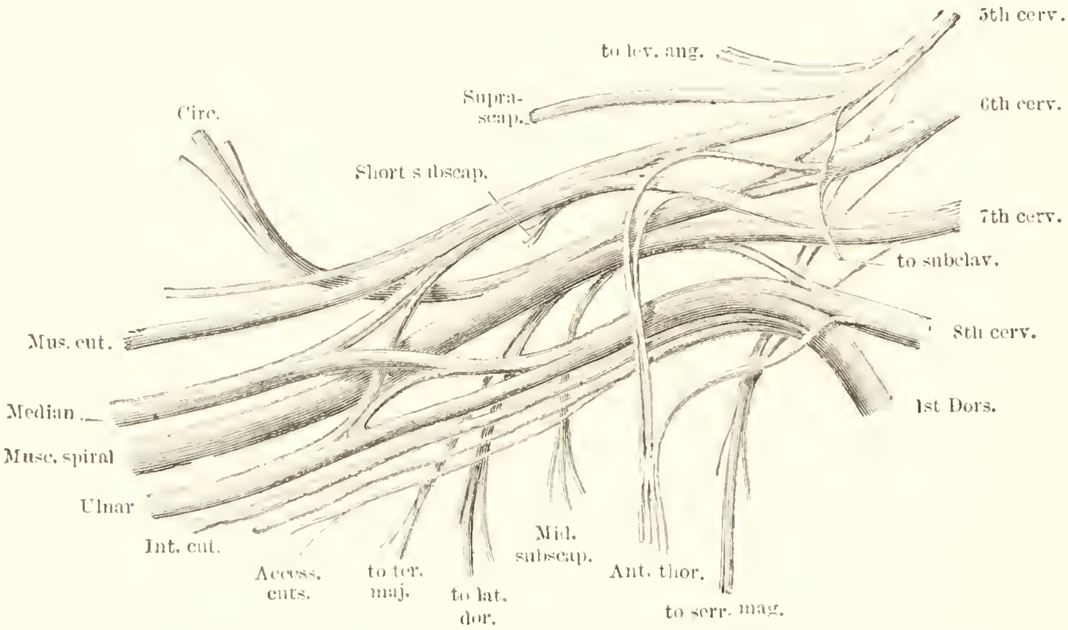


FIG. 51.—DIAGRAM OF RIGHT BRACHIAL PLEXUS, RESEMBLING THE FIRST DESCRIPTION IN THE TEXT.

The long subscapular, the largest of the three, accompanies the subscapular artery and enters the latissimus dorsi near its outer end.

The *Posterior Thoracic*, or *External Respiratory Nerve of Bell*, is given off from the brachial plexus above the clavicle, but passes into the axilla behind the axillary vessels and lies on the axillary surface of the serratus magnus.

The **Latissimus Dorsi.** The insertion of this muscle may now be examined. Its origin from the spinal column will be subsequently dissected. Its fibres cross the inferior angle of the scapula and sometimes receive a few fibres from it, and then curve round the lower border of the teres major and twist upon themselves so that the *superior* fibres are at first posterior and then inferior, and the *lower* fibres are at first anterior and then superior. Its tendon is about three inches long, and two and a half inches in width, and quadrilateral, and passes in front of that of the teres major to be inserted into the inner lip and bottom of the bicipital groove.

Its insertion extends higher than those of the pectoralis major and teres major, and it is connected with the tendon of the teres, a bursa intervening. There is sometimes a bursa between the latissimus and the dorsum of the inferior scapular angle.

Peculiarities.—Muscular slips (axillary arches) occasionally are given off from the upper edge of this muscle about the middle of the posterior

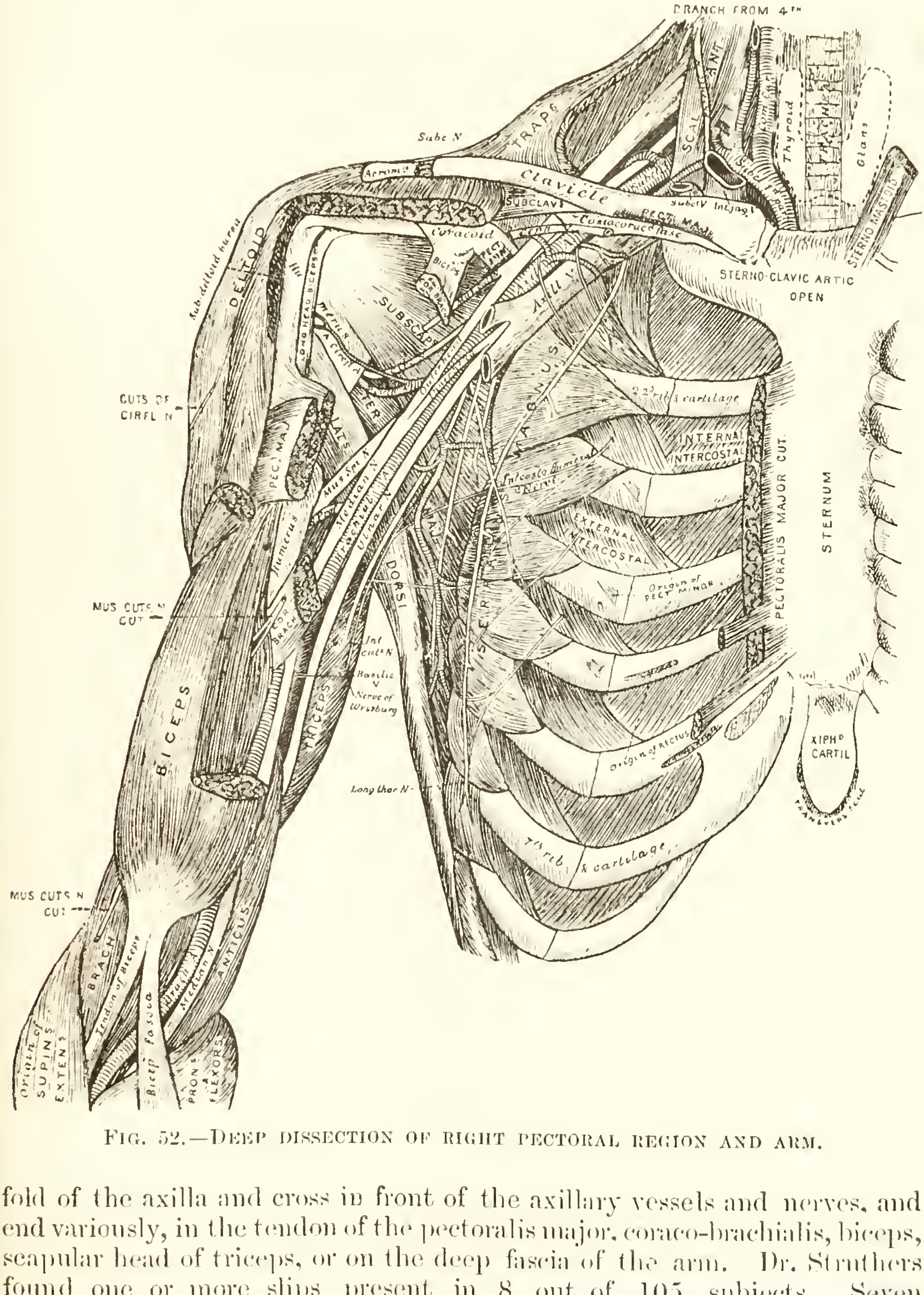


FIG. 52.—DEEP DISSECTION OF RIGHT PECTORAL REGION AND ARM.

fold of the axilla and cross in front of the axillary vessels and nerves, and end variously, in the tendon of the pectoralis major, coraco-brachialis, biceps, scapular head of triceps, or on the deep fascia of the arm. Dr. Struthers found one or more slips present in 8 out of 105 subjects. Seven times it occurred on both sides. It may be recognised by the transverse

directions of its fibres and thus prevent the surgeon being misled in ligaturing the axillary artery.

Dissection.—Draw the arm away from the trunk so as to separate the scapula from the thorax, cut through the brachial plexus opposite the third rib, and clean the serratus magnus muscle.

The **Serratus Magnus** is a broad and irregularly quadrilateral muscle, passing from the upper part and side of the thorax to the scapula. It arises by nine pointed fleshy digitations from the outer surfaces and upper borders of the eight upper ribs (the second rib having two), about two

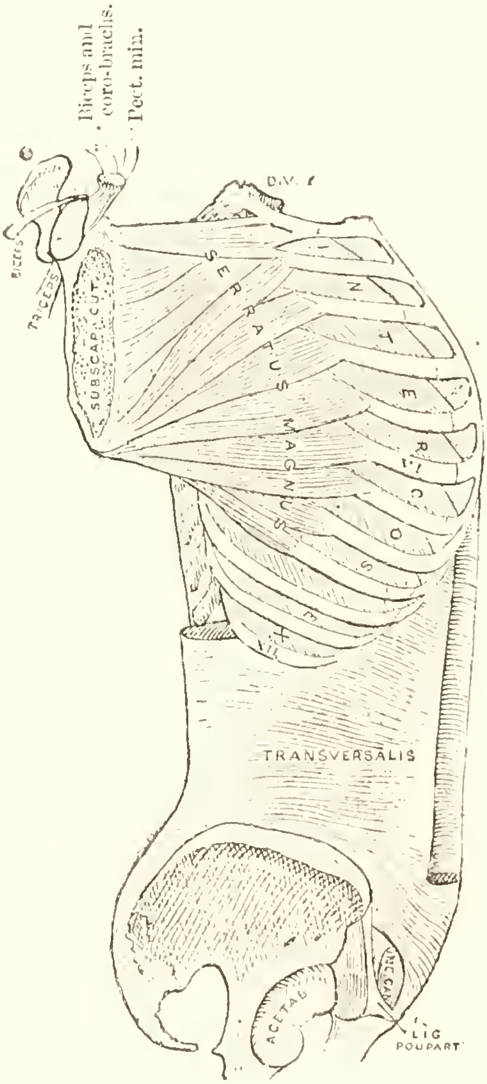


Fig. 53.—Diagram to show the origin of the serratus magnus.

inches from their cartilages; also from the aponeurosis over the upper intercostals. The fibres approximate to be inserted into the whole length of the inner margin of the posterior border of the scapula. In consequence of the difference in their direction and extent of attachment, the fibres of this muscle have been described as consisting of three parts—a superior, middle, and inferior. The *upper portion*, which is slightly separated from the middle, is narrow and thick, and arises by *two* digitations from the first and second ribs, and an aponeurotic arch between them. It

passes up, out and back, to be inserted on the triangular smooth surface on the anterior aspect of the superior scapular angle. The *middle* portion is very thin, and arises by *three* serrations, from the second, third, and fourth ribs, and forms a broad layer extending horizontally back to be inserted into the posterior border of the scapula between the superior and inferior angles. The *lower* part is the strongest and arises by *four* digitations from the fifth, sixth, seventh, and eighth ribs, inter-digitating with corresponding processes of the external oblique. The fibres pass up, out and back, and are inserted into the inner or costal surface of the

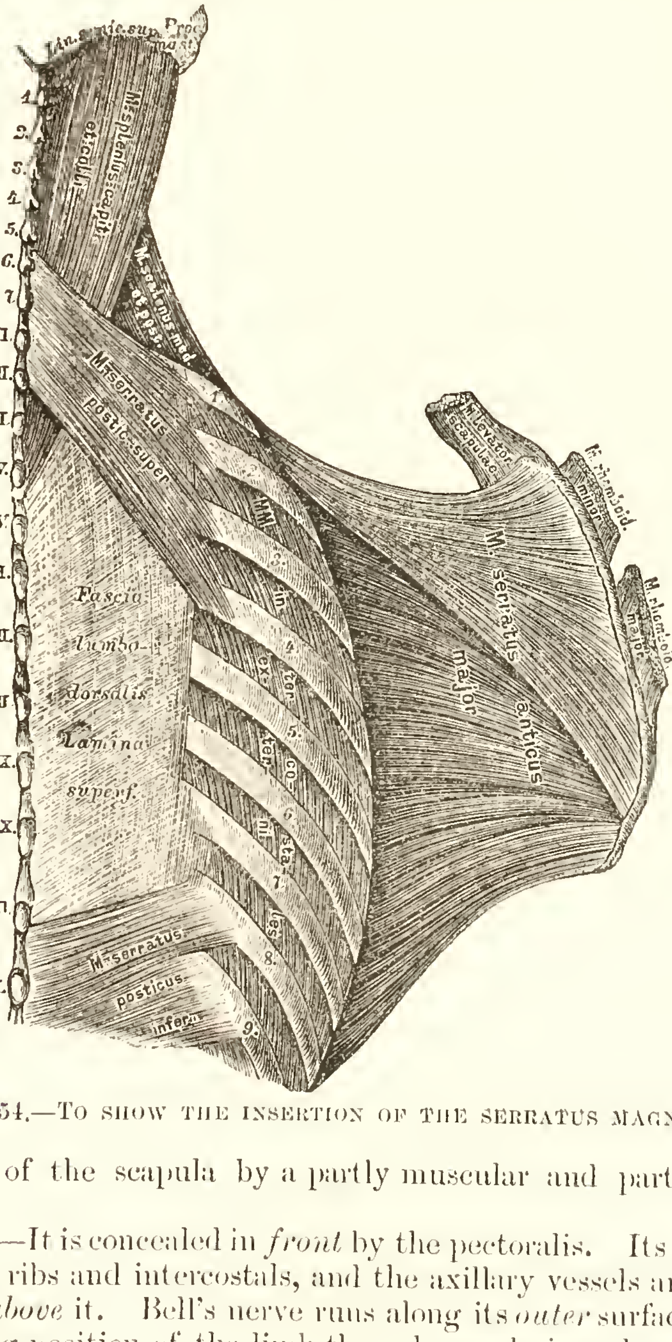


FIG. 54.—TO SHOW THE INSERTION OF THE SERRATUS MAGNUS.

inferior angle of the scapula by a partly muscular and partly tendinous attachment.

Relations.—It is concealed in *front* by the pectoralis. Its *deep* surface rests upon the ribs and intercostals, and the axillary vessels and nerves are in *front and above* it. Bell's nerve runs along its *outer* surface, and in the ordinary resting position of the limb the subscapularis and scapula are in contact with it.

Action.—Taking its fixed points from the ribs it will draw the scapula

forwards. Its middle and lower portions can draw the base and inferior angle of the scapula forwards, and rotate the bone round an axis through its centre, and can raise the acromion and therefore the point of the shoulder. If its fixed point be at the scapula, it is the most important *external inspiratory* muscle, as it elevates the ribs and assists the pectoralis and subclavius in expanding the chest.

Nerve.—The posterior thoracic (Bell's nerve).

Varieties.—Sometimes the lowest slip extends to the tenth rib and sometimes the number of digitations is diminished either by the suppression of the first, but more frequently by the absence of some of the lower digitations, the seventh then being the last. Its three portions may be quite distinct, and the middle part may be absent. It may form one muscle with the levator scapulæ, or may be partially united with the external oblique or external intercostals.

Dissection.—Detach the digitations of the serratus magnus from the ribs and clean the surface of the intercostal muscles, preserving a thin aponeurosis which passes from each external intercostal muscle to the sternum. Note the lateral cutaneous thoracic nerves.

Intercostal Fascia.—A firm thin layer of fascia covers the outer surface of the external intercostals and the inner surface of the internal, and a more delicate third layer is interposed. These intercostal fasciæ are best marked where the muscular fibres are deficient, as between the external intercostals and sternum in front, and between the internal intercostals and spine, behind.

The **Intercostal Muscles** are named from their position. They consist of two thin layers of short oblique fibres, and are named external and internal. Neither fills the whole length of the intercostal space. The external pass obliquely down and forwards between the bony portions of the ribs, and the internal have an opposite direction, so that they cross.

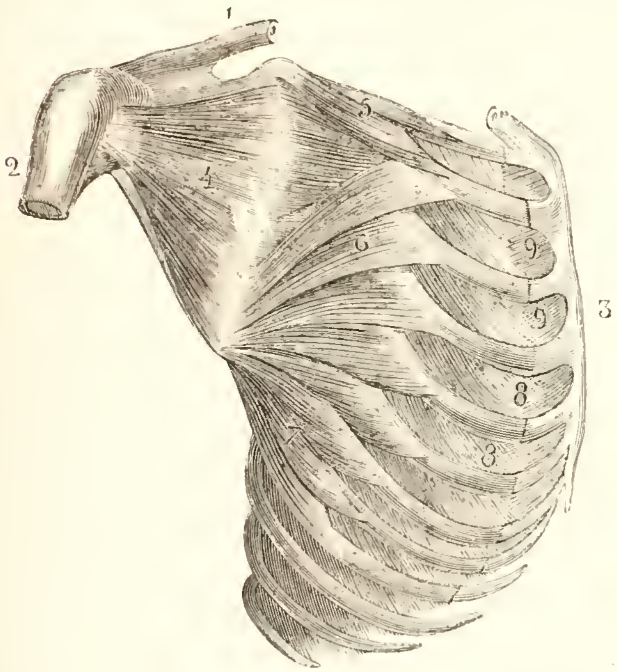
The **External Intercostals** are eleven on each side, and consist of muscular with tendinous fibres directed obliquely forwards and downwards, passing from the outer margin of the groove on the lower margin of the rib above to the upper border of the rib below. For the most part they extend from the tubercles of the ribs posteriorly to near the outer end of the cartilages. Between the true ribs they cease near the cartilages, and a thin aponeurosis having the same direction is continued forwards between the cartilages from where the muscular fibres cease to the sternum, there covering the internal intercostals. In the lower spaces these muscles are continued between the cartilages, and in the last two they reach to the ends of the spaces.

Relations.—*Externally* with the pectoralis major and minor, serratus magnus, rhomboid major, both serrati, scalenus posticus, sacro-lumbalis, longissimus dorsi, cervicalis ascendens, transversalis colli, levatores costarum, and external oblique. *Internally* with the internal intercostals and intercostal vessels and nerve, from which they are separated by the middle layer of fascia; and *behind* from the pleura.

Directions.—To expose the internal intercostals, remove the externals from one or two of the widest spaces, and the muscles will be recognised by the difference in the directions of their fibres. Between the outer and inner intercostals, at the back parts of the spaces, the intercostal vessels and nerves will be seen. A lateral cutaneous branch of the nerve may be

traced through the external muscle, and the intercostal trunk should be traced forwards to the sternum and surface of the chest. Only the anterior parts of these muscles can now be dissected.

The **Internal Intercostals** are deeper than the preceding, are also eleven in number, and are attached above to the inner margins of the grooves, and below to the upper margins of the ribs and their cartilages. Beginning at the anterior ends of the costal cartilages they pass back to near the costal angles. The fibres pass down and back, crossing those of the external, but are shorter and less oblique. They do not end behind at the same distance from the spine, for the middle are further removed from the spinal column than the upper and lower, and in the two lowest spaces anteriorly these muscles are continuous with the fibres of the internal oblique.



1. Clavicle.
2. Humerus.
3. Sternum.
4. Subscapularis.
5. Upper fibres of serratus magnus.
6 and 7. Lower fibres of serratus magnus.
8. Anterior ends of external intercostals.
9. Anterior end of internal intercostals.

The white line separates the insertion of the serratus magnus from the origin of the subscapularis.

FIG. 55.—LATERAL VIEW OF THORAX AND INTERCOSTALS ON THE RIGHT SIDE, THE SCAPULA THROWN BACKWARDS.

Relations.—Internally with the pleura, triangularis sterni, and diaphragm; and *externally* with the intercostal vessels and nerve, which separate them from the external intercostals.

Actions.—The external muscles are elevators of the ribs, and consequently muscles of *inspiration*. They also evert the lower edges of the ribs and enlarge the antero-posterior and transverse diameters of the thorax. The internal intercostals are also rib elevators, but some anatomists are inclined to the view that that portion of them which is between the bony parts of the ribs depresses and inverts those bones, diminishing the capacity of the thorax, and that they are thus *expiratory*, while the intercartilaginous portion raises the ribs and is *inspiratory*. The view that both muscles are *elevators and inspiratory* muscles is strengthened by many physiological experiments and pathological facts. The crossing of the two sets of muscles, the three layers of fasciæ, and the length and predominance of the tendinous fibres in these muscles give great strength to the intercostal spaces.

Nerves.—The intercostal nerves supply these muscles.

Dissection.—Cut through and remove the cartilages of the 2nd, 3rd, 4th, 5th and 6th ribs, also the intervening structures; preserve the intercostal vessels and nerves; clean away some loose fatty tissue, and the outer surface of the triangularis sterni will be seen.

The **Triangularis Sterni** is a thin stratum of muscular and tendinous fibres within the thorax posterior to the costal cartilages. It arises from the posterior surfaces of the ensiform cartilage, from the side of the lower part of the sternum, as high as the third costal cartilage, and from the cartilages of one or two of the lower true ribs. Its fibres diverge out and up, the upper being nearly vertical, the middle oblique, and the lower hori-

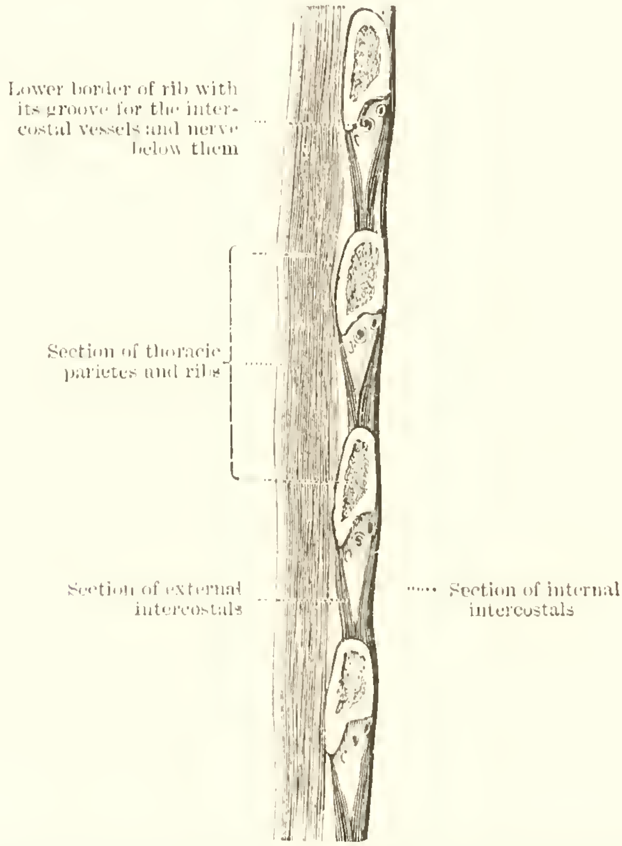


FIG. 56.—VERTICAL SECTION THROUGH THE RIBS OF THE RIGHT SIDE, ABOUT MIDWAY, TO SHOW THE RELATIONS OF THE INTERCOSTAL MUSCLES.

zontal. They are inserted by separate fleshy slips into the true ribs from the sixth to the second inclusive, on the lower border and inner surface of each, at the junction of the bone with the cartilage, and into the intercostal aponeurosis. Its lower horizontal fibres are in the same plane with the transversalis abdominis, of which this muscle is an upward continuation.

Relations.—*Behind* with the pleura, *in front* it is covered by the costal cartilages, internal costal muscles, internal mammary vessels, and the ends by the intercostal vessels and nerves.

Action.—It assists in depressing the anterior ends of most of the true ribs, and thus diminishes the thoracic capacity. It acts as an expiratory muscle.

Nerves.—Upper intercostal nerves.

Varieties.—This muscle is subject to much variation as to its extent and attachment, and may vary on the opposite sides of the same body.

The **Internal Mammary Artery** is a branch of the first part of the subclavian, and is given off from its under surface opposite the thyroid axis. It passes into the thorax behind the clavicle, and rests on the costal cartilages near the sternum, and between the sixth and seventh cartilages it divides into the musculo-phrenic and superior epigastric. It passes beneath the seventh rib and enters the sheath of the rectus, and is accompanied by two veins, which unite by a single trunk at the upper part of the thorax, and by some lymphatic vessels and glands.

Relations.—At its origin it is concealed by the internal jugular and subclavian veins, and crossed by the phrenic nerve. At the upper part of

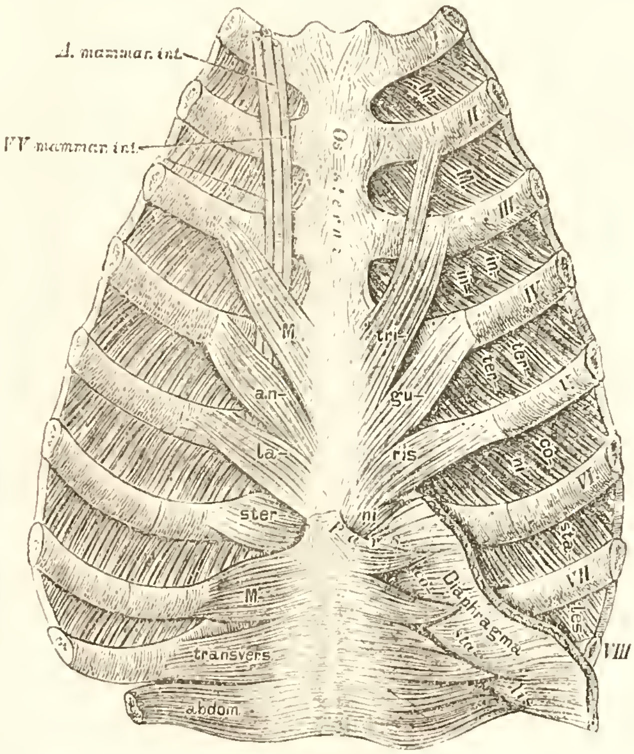


FIG. 57.—THE MUSCLES ATTACHED TO THE STERNUM AND UPPER RIBS SEEN FROM BEHIND.

the thorax it is between the costal cartilages and internal intercostals *in front*, and the pleura and transversalis sterni *behind*. This latter muscle separates it from the pleura at the lower part of the thorax.

Branches.—The *comes nervi phrenici*, or *superior phrenic*, is a long slender branch given off from the internal mammary as the artery enters the thorax. It accompanies the phrenic nerve between the pleura and pericardium, to which it is distributed, and joins the phrenic branches of the abdominal aorta and the musculo-phrenic.

The *Mediastinal* branches are small vessels which supply the pericardium, the remains of the thymus gland, the transversalis sterni, and the cellular tissues in the anterior mediastinum.

The *Pericardiac* branches supply the upper part of the pericardium, the lower part of which is nourished by the musculo-phrenic.

A few *sternal branches* go to both surfaces of the sternum and to the triangularis sterni.

The *Anterior Intercostal* arteries pass outwards in the five or six

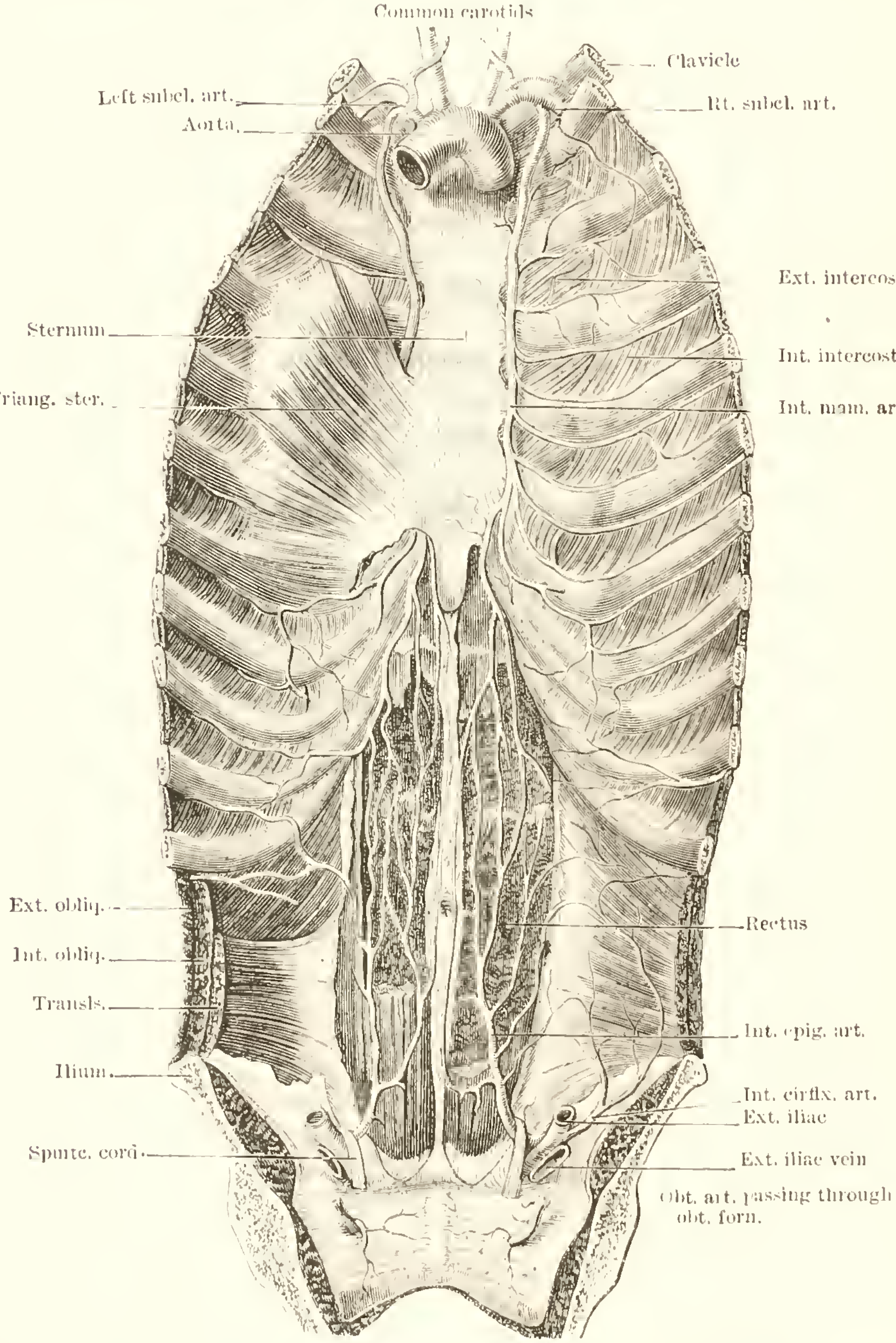


FIG. 58.—INTERNAL MAMMARY AND EPIGASTRIC ARTERIES SEEN FROM BEHIND.

The left mammary is seen passing between the intercostals and triangularis sterni. Its anastomoses with the intercostals are shown on the right side. The iliacus and obturator internus are seen in section between the divided pelvic fascia and bones. The symphysis pubis is seen through the fascia.

upper spaces, and divide into two branches, which are situated on each border of the costal cartilages and anastomose with the aortic intercostals. They supply the intercostals, pectorals, and mammary glands, and are first

placed between the pleura and internal intercostals, and then between the outer and inner intercostal muscles.

The *Perforating Arteries* are one or two for the five or six upper spaces. They pierce the internal intercostals and pectorals which they supply, and are finally distributed to the skin with the anterior cutaneous nerves. The arteries of the first three spaces supply the mamma and are enlarged during lactation.

The *Musculo-Phrenic Branch* passes down and out behind the cartilages of the seventh and of the false ribs, and pierces the diaphragm at the eighth or ninth rib, ending, much reduced in size, opposite the last intercostal space. It furnishes anterior intercostal branches to the lower spaces and diminishes in size, being distributed similarly to the anterior intercostals of the internal mammary. Its branches to the diaphragm and abdominal muscles will be seen in a subsequent dissection. Two veins accompany this artery and unite into a single trunk, which ends in the innominate vein.

The *Superior Epigastric* is a continuation of the internal mammary, and passes down behind the rectus, then pierces its sheath, and divides into branches that supply it and anastomose with the epigastric from the external iliac. A small branch passes inwards in front of the ensiform cartilage, and joins its fellow of the opposite side. A few twigs pierce the sheath of the rectus and supply the muscles of the abdomen and skin.

The **Intercostal Nerves.**—The anterior portions of these nerves are now seen. They are the anterior primary branches of the *dorsal spinal* nerves and supply the thoracic wall. They accompany the intercostal vessels and pass between the outer and inner intercostals supplying them, and about midway between the spine and sternum each gives off a cutaneous nerve; then much diminished in size they pass forwards in the fibres of the internal intercostals as far as the costal cartilages, where they are beneath the internal intercostals and in contact with the pleura. Near the sternum they cross the internal mammary artery and the triangularis sterni, supplying it. These nerves end, after piercing the internal intercostals and the pectoralis major, in the skin of the breast, and are called the *anterior cutaneous thoracic* nerves.

The **Intercostal Arteries** accompany the nerves between the intercostal muscles. They lie nearer the upper than the lower rib, and are branches of the thoracic aorta. About midway between the spine and sternum each vessel divides, one branch following the upper rib and the other the lower, and both inosculate in front with the intercostal branches of the internal mammary. They supply the intercostal muscles and give off small cutaneous twigs, which are distributed with the lateral cutaneous thoracic nerves.

Directions.—When the body is turned the possessor of the arm must dissect the superficial muscles of the back; and when this is done, he must remove the limb from the trunk by sawing through the clavicle at its middle and cutting through the muscles fixing the scapula to the trunk.

DISSECTION OF SCAPULO-HUMERAL REGION.

Directions.—Place the separated limb so that the subscapularis looks uppermost, and leave about two inches of the muscles which pass from the trunk to the arm attached to the humerus.

Position of Parts.—The posterior belly of the omo-hyoid will be found attached at the upper margin of the scapula near the notch.

Many muscles are attached along the base of the bone. The levator anguli scapulæ is between the spine and the superior angle; and opposite the spine is the insertion of the rhomboideus minor. Between the spine and the inferior angle the rhomboideus major is inserted. The serratus magnus is inserted along the base of the scapula, beneath or anterior to these muscles.

The long head of the triceps arises from the lower margin or costa, where also is part of the origin of the teres major.

On the outer surface of the inferior angle is another part of the origin of the teres major, and on the anterior aspect of the superior and inferior angles are the upper and lower fibres of the serratus magnus.

The muscles attached to the coracoid process are, from within outwards, the pectoralis minor, which is inserted at its innermost facet, and the coraco-brachialis and short head of the biceps, which arise conjointly from it.

Dissection.—Reflect the serratus towards its attachment to the scapular base, and define the connections of the thin fascia covering the subscapularis.

The subscapular fascia or aponeurosis is thin, and is attached to the circumference of the subscapular fossa, and gives origin to some of the fibres of the subscapularis.

Between the scapular attachments of the serratus magnus and rhomboideus major the posterior scapular artery and vein will be found, and their branches and communications must be subsequently traced.

Dissection.—Remove this fascia, and the subscapularis will be exposed.

The **Subscapularis Muscle** is large and triangular, and occupies the subscapular fossa arising from its inner two thirds, except from the neck and angles, and a narrow margin along the posterior border. Some fibres take origin from the tendinous laminæ which intersect it, and are united to the ridges on the venter of the scapula, and others take origin from the subscapular fascia and from an aponeurosis which separates the subscapularis from the teres major and long head of the triceps. It is inserted by a tendon into the lesser tuberosity of the humerus, and the fibres which arise from the axillary costa of the scapula are inserted into the humeral neck for about an inch below the tuberosity. The tendon of this muscle is intimately blended with the shoulder capsule, and in some instances it pierces it.

Relations.—*Anteriorly* with the serratus magnus, coraco-brachialis, short head of biceps, and axillary vessels and nerves. *Posteriorly* with the scapula, subscapular vessels and nerves, and the capsular ligament of the shoulder. Between its tendon and the base of the coracoid process is a large bursa which communicates with the synovial cavity of the joint. Frequently this bursa is a prolongation of the synovial membrane of the

shoulder. Its *lower border* is contiguous with the teres major, long head of triceps, and latissimus dorsi, a bursa sometimes intervening; also with the subscapular artery and its dorsal branch, and near its *upper border* are the supra-scapular vessels and nerve.

Actions.—It is an internal rotator of the humerus, and will draw the bone down if the arm has been raised. If the humerus be fixed, it can draw the scapula towards it, and with the other scapular muscles will support the joint. It tends to prevent luxation of the humeral head forwards.

Nerves.—The upper and middle subscapular.

Varieties.—A small extra muscle sometimes passes from the surface

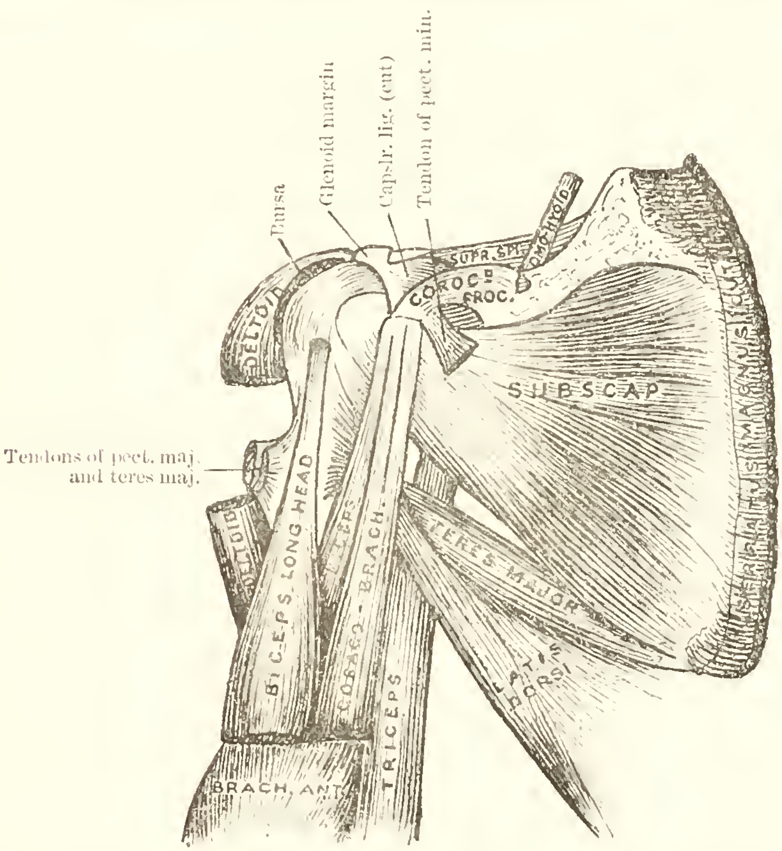


FIG. 59.—SHOWING THE ATTACHMENTS OF THE SCAPULO-HUMERAL MUSCLES.

of the subscapularis into or near the inner bicipital ridge. *Gruber* has named this the *Subscapulo-capsularis.*

Other fasciculi have been observed passing either from the inferior part of the external border of the scapula to the lesser tuberosity, or from its tendon to the skin covering the axilla. An *accessory subscapular* muscle is sometimes found passing from the upper part of the axillary border in front of the long head of the triceps and of the capsule to be inserted into the humerus between the subscapularis and teres major.

Dissection.—Separate the subscapularis from the bone and note its tendinous septa, three or four of which are attached to the scapular ridges, and others pass inwards from its tendon. Observe the bursa near the coracoid process, and sometimes a second between it and the latissimus

dorsi and teres major, and note if the tendon pierce the capsule. Dissect out the anastomoses on the venter of the scapular between the infra-scapular branches of the dorsalis scapulæ and branches of the supra and posterior scapular arteries; then place the scapula on its ventral surface, and put a block between the humerus and the axillary border of the bone, so as to render the shoulder prominent. Now remove the skin from the shoulder, beginning at the anterior border of the deltoid. Seek in the fat the cutaneous nerves of this region.

Cutaneous Nerves.—The acromial branches from the descending branches of the cervical plexus ramify over the acromion, and are called *super-* or *supra-acromial.* They pass obliquely over the acromion, and outer surface of the triceps, and supply the skin over the upper and back part of the shoulder, and join the cutaneous filaments of the circumflex and supra-scapular nerves.

The cutaneous filaments of the circumflex will be found about half-way along the posterior border of the deltoid, and another near the anterior part of its insertion. They come from the upper and lower branches into which the circumflex divides, and supply the skin in their respective regions joining the acromial branches of the superficial cervical plexus.

Dissection.—Make the fibres of the deltoid tense by using hooks, and remove the fat, and after having observed the attachments of the deltoid fascia, it also must be reflected.

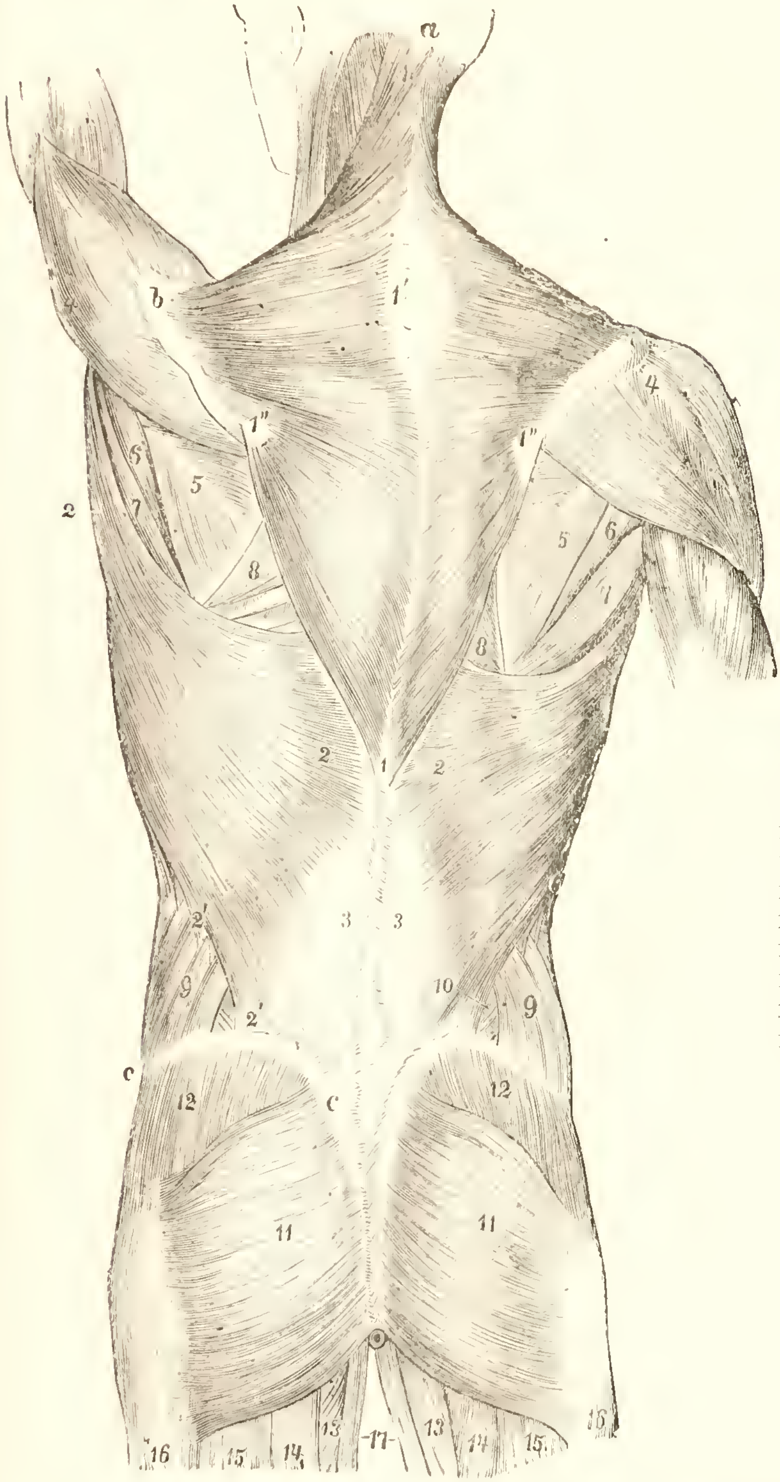
The *Deltoid Fascia* or *Aponeurosis* is thick and strong; it covers the outer surface of the muscle and sends many processes between its fibres. Internally it is continuous with the fascia over the pectoralis major; above it is attached to the margins of the clavicle, acromion and spine of the scapula; and behind it is continuous with the fascia over the infra-spinatus and back of the arm.

Dissection.—Remove this fascia, beginning at the anterior edge of the deltoid, and as the posterior border is neared, some cutaneous branches of the circumflex artery and nerve will be observed coming round it.

The **Deltoid** is a triangular thick and strong muscle with its base, which is concave above, and its apex at the humerus. It arises from the outer half or third of the anterior border and upper surface of the clavicle, from the anterior and outer margins and upper surface of the acromion, and from nearly the whole length of the lower border of the spine of the scapula. It surrounds the shoulder joint on its outer side, and in front and behind. The fibres converge to form a thick tendon, the anterior fibres passing obliquely backwards, the middle vertically downwards, and the posterior obliquely forwards. It is inserted into a triangular surface two or three inches long and an inch wide at its base, just above the middle of the outer side of the humeral shaft. This coarse muscle is intersected by three or four tendinous laminæ, which are fixed at intervals to the acromion and clavicle, and passing into the substance of the muscle, give origin to numerous fleshy fibres. The largest of these laminæ is attached to the summit of the acromion.

Relations.—*Superficially* with the skin, superficial fascia, deltoid fascia, platysma, and supra-acromial nerves. *Deeply* (parts covered by deltoid), it covers the head of the humerus, a large multilocular bursa intervening. It also covers the coracoid process, coraco-acormial ligament, insertions of pectoralis minor, infra-spinatus, supra-spinatus, subscapu-

laris, and teres minor, and origins of the scapular and external heads of the triceps, and of the coraco-brachialis, and both heads of biceps, the



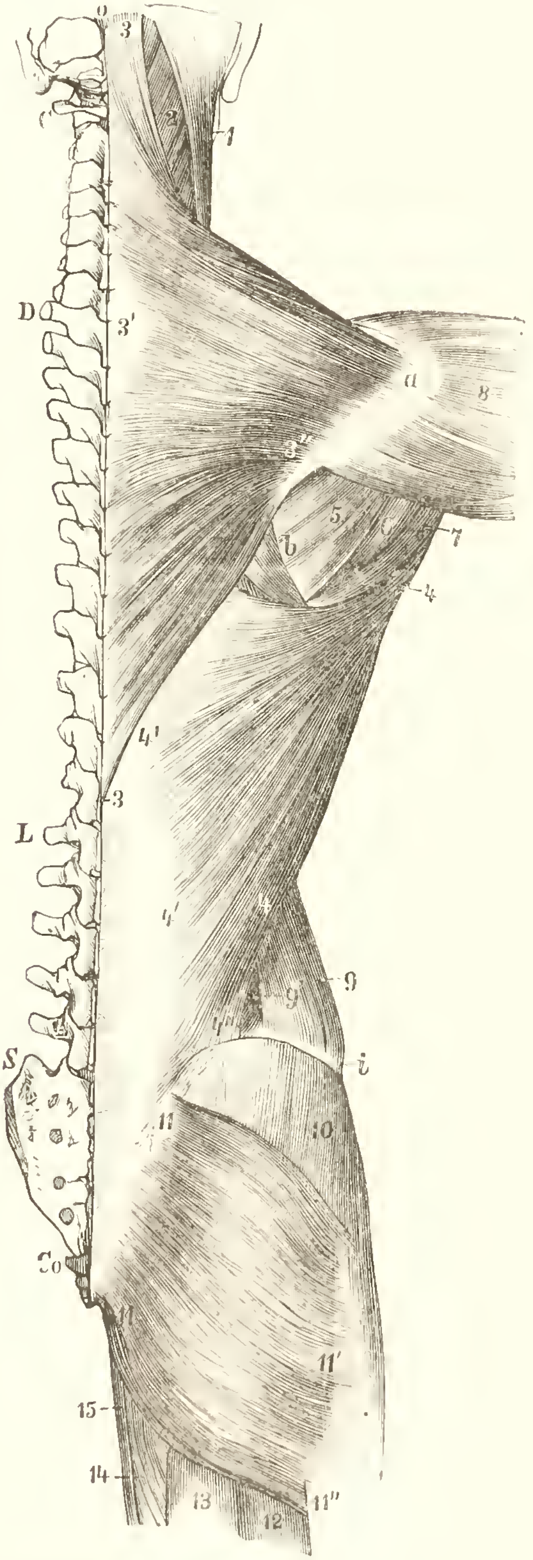
a. Ext. occip. protuberance.
b. Acromion.
c. Iliac crest.
1. Trapezius; between the two is the ovoid tendon.
1'. Rhomboid.
1''. Triangular tendons of trapezius.
2. Lat. dorsi.
2' 2'. Muscular fasciculi arising from iliac crest and ribs.
3. Lumbar fascia.
4. Deltoid.
5. Infra-spinatus.
6. Teres minor.
7. Teres major.
8. Rhomboid major.
9. Ext. oblique.
10. Petit's triangle.
11. Gluteus maximus.
12. Gluteus medius.
13. Add. mag.
14. Semitend.
15. Biceps.
16. Fascia lata.
17. Gracilis. Beneath the right deltoid is the triceps, and in front of the left is the biceps.

FIG. 60.—SUPERFICIAL MUSCLES OF THE TRUNK. POSTERIOR VIEW, ONE-FIFTH.

The student should now only refer to the muscles described in the text.

circumflex vessels and nerves, and the humerus. *Anteriorly*, a cellular space separates it from the pectoralis major, in which are found the cephalic

vein and descending branches of the acromial-thoracic artery. Its *posterior border* rests on the infra-spinatus and triceps. The cutaneous branches of the circumflex are found along its anterior and posterior borders.

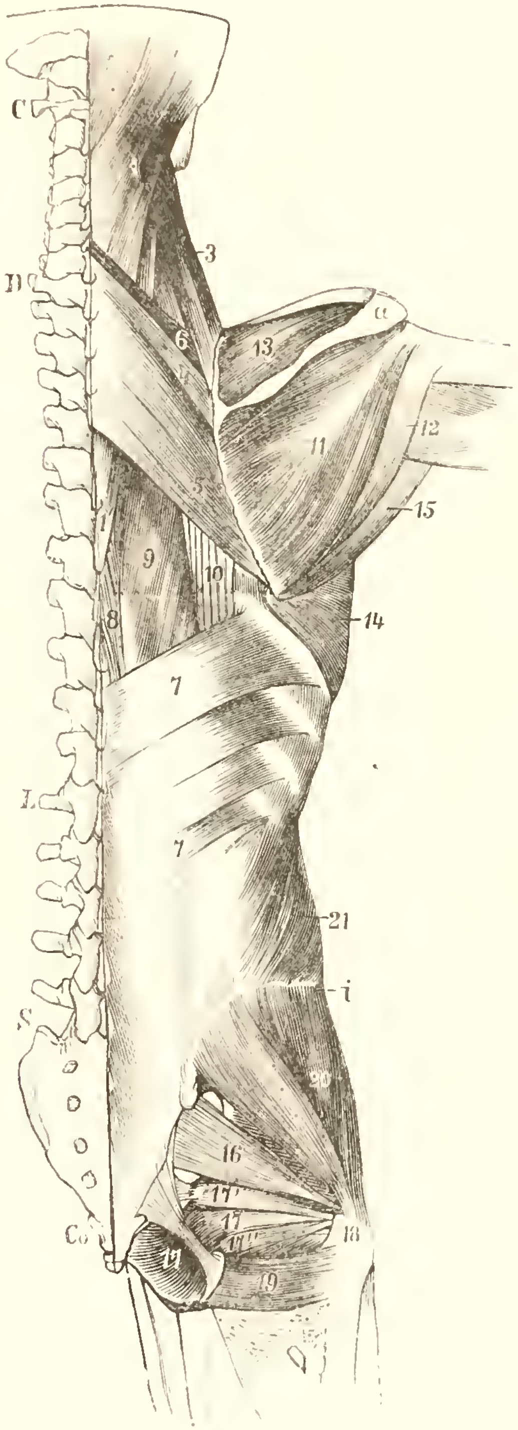


O. Occipital protuberance.
C. Trans. process of atlas.
D. First dorsal vertebra.
L. „ lumbar „
S. Sacrum.
Co. Coccyx.
a. Acromion.
b. Base of scapula, the rhomboid major to its inner side.
i. Crest of ilium.
1. Sterno-mastoid.
2. Splenius, lev. ang. scap., &c.
3 3. Origin of trapezius.
3'. Half of its oval tendon.
3''. Its triangular tendon.
4 4. Lat. dorsi.
4' 4'. Its origin from lumbar fascia.
5. Infra spinatus.
6. Teres minor.
7. Teres major.
8. Deltoid.
9 9. Ext. oblique; the int. obl. is between it and lat. dorsi.
10. Glut. medius.
11. Origin of glut. max.
11'. Its insertion into fascia lata.
11''. „ „ femur.
12. Biceps.
13. Semitendinous.
14. Add. magnus.
15. Gracilis.

FIG. 61.—THE SUPERFICIAL MUSCLES OF THE RIGHT SIDE. POSTERIOR VIEW.

[See note to previous figure.

Its origin corresponds with the insertion of the trapezius, and its tendon of insertion joins that of the pectoralis major, and the two heads of origin of the brachialis anticus are attached at each side of it.



1. Splenius cap. et colli.
1'. Lower part of spl. colli.
2. Complexus.
3. Lev. ang. scap.
4. Rhomb. min.
5. „ maj.
6. Part of serr. post. sup.
7 7. Serr. post. inf.
8. Part of spinalis dorsi.
9. Part of long. dorsi.
10. Part of sacro lumbalis.
11. Infra-spinatus.
12. Long head of triceps.
13. Supra-spinatus.
14. Serr. mag.
15. Teres major.
16. Pyriformis.
17 17. Obt. int.: between the figures is the lesser sacro-sciatic lig.
17'. Gemellus sup.
17''. „ inf.
18. Tendon of obt. ext.
19. Quadratus femoris, beneath which is the upper part of the add. mag. with opening for sup. perforating art.
20. Gluteus medius.
21. Internal oblique.

The bones are lettered as in the preceding figure.

FIG. 62.—DEEPER MUSCLES OF THE RIGHT POSTERIOR ASPECT.

See note to previous figure.

Actions.—Acting as a whole it abducts the humerus and raises it to a right angle with the trunk. If the limb be raised its anterior fibres aid

the pectoralis major in drawing the arm forwards, and its posterior fibres assist the teres major and latissimus dorsi in drawing it backwards. In climbing, the humerus being fixed, it strengthens the joint and assists in supporting the body weight.

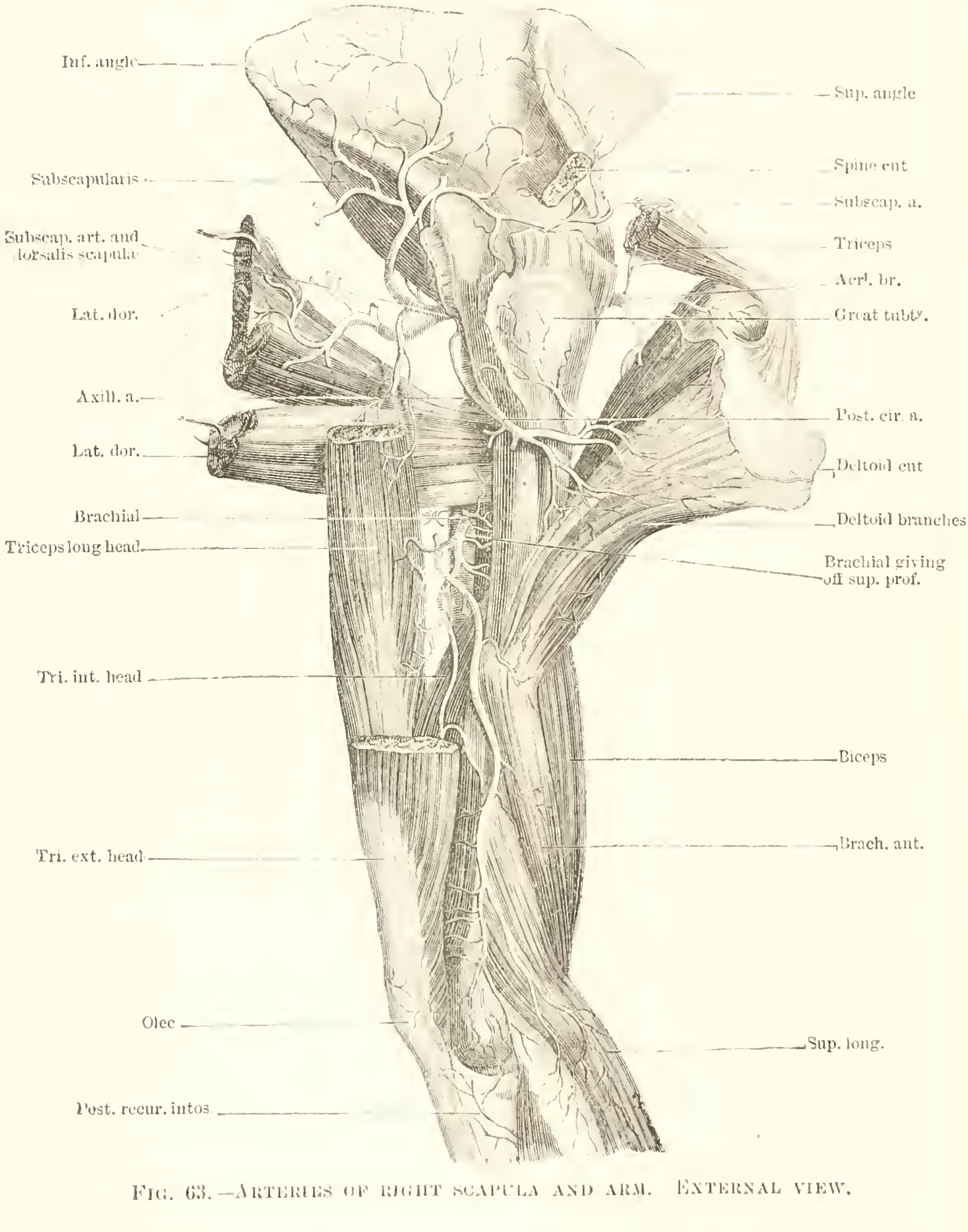


FIG. 63.—ARTERIES OF RIGHT SCAPULA AND ARM. EXTERNAL VIEW.

Nerve.—The circumflex.

Varieties.—This muscle is not uncommonly subdivided into its three sets of fibres, and sometimes fibres of the trapezius are continued into it, as in animals without clavicles. Its anterior part is occasionally united

with the pectoralis major, and its insertion varies in extent. *Macalister* has described a prolongation of its tendon on the radial border of the fore-arm to the tendon of the supinator longus. This appears to repeat the *tensor plicæ alaris* of the bird.

Dissection.—Detach the deltoid near its base, and reflect it so far as permitted without cutting the circumflex vessels and nerves beneath it. Notice the large sacculated bursa between the acromion process, the muscle, and the shoulder joint. Clean the circumflex vessels and nerves, remove the remains of the bursa, and examine the insertion of the muscle, noting how the main tendon separates from below upwards for some dis-

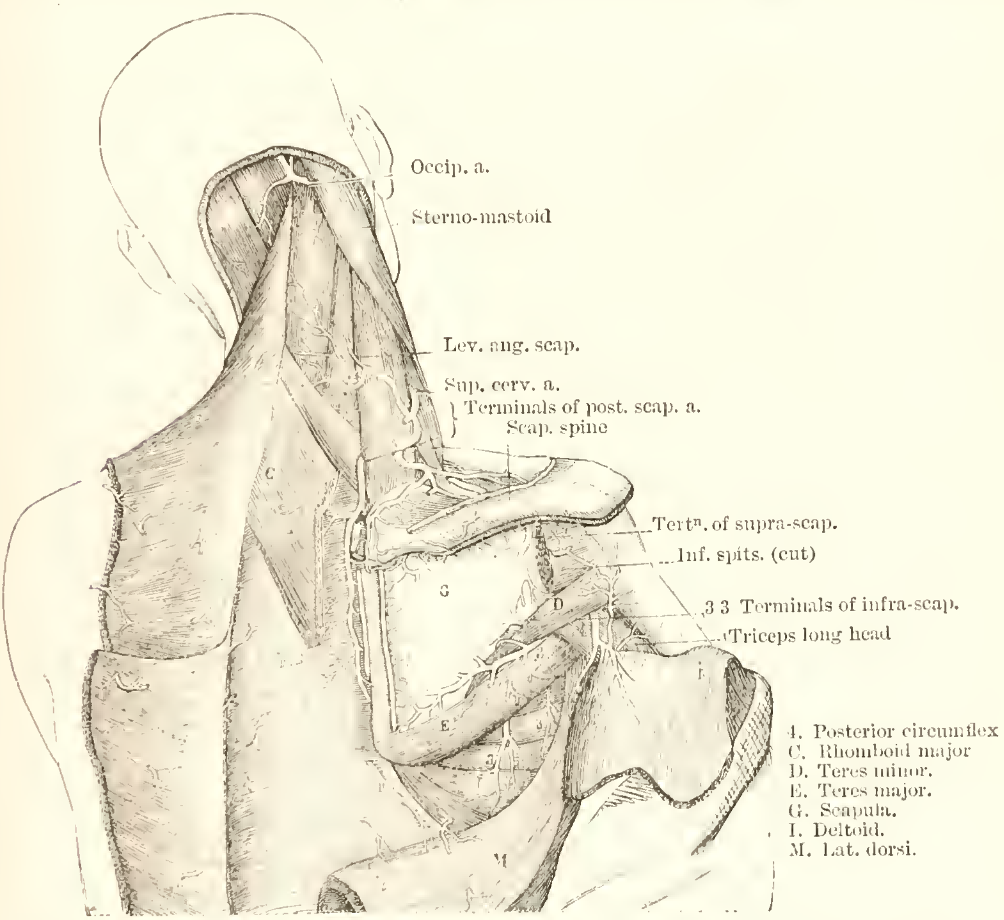


FIG. 64.—POSTERIOR VIEW OF RIGHT SCAPULAR AND CIRCUMFLEX ARTERIES.

tance over the under surface of the muscle. One or two of the larger tendinous intersections should be sought, to observe the penniform arrangement of the fibres which arise from them, and to define some wedged-shaped bundles of muscular fibres between the penniform bundles. These arise directly from the acromion, and are inserted into the tips of the lower tendinous septa, and others which spring from the ends of the upper tendinous septa are inserted into the humerus, between the lower septa. The parts enumerated as being beneath the deltoid in giving its relations should now be defined; and this being done, the posterior circumflex vessels and circumflex nerve should be followed through a quadrangular space between the humerus externally, and the long head of the triceps

internally, the teres minor above and latissimus dorsi and teres major below, to their origins from the axillary artery and posterior cord of the brachial plexus. In this space, a branch from the circumflex nerve to the teres minor muscle will be found near the scapular border surrounded by strong fibrous tissue. This branch has a *gangliform* enlargement on it.

There are two *circumflex arteries*, branches of the last part of the axillary trunk. They are anterior and posterior.

The *Anterior Circumflex* is a small vessel which passes transversely out beneath the coraco-brachialis and biceps, and in the bicipital groove divides into an ascending branch, which supplies the shoulder joint and

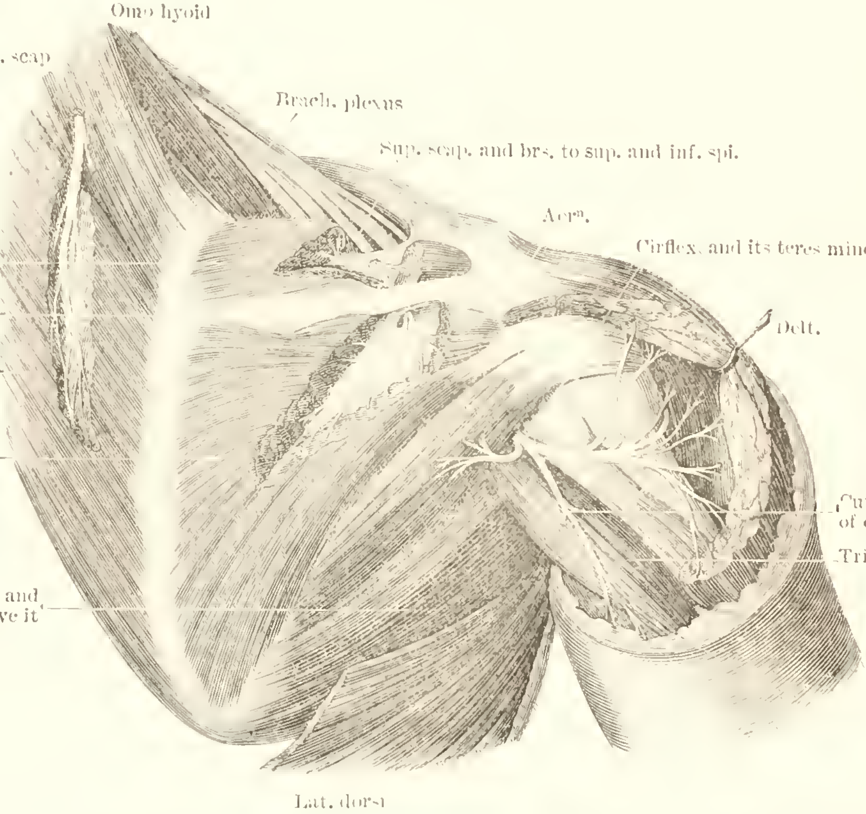


FIG. 65.—POSTERIOR BRANCHES OF BRACHIAL PLEXUS. RIGHT SIDE.

the head of the humerus, and its continuation passes beneath the deltoid to supply it and anastomose with the posterior circumflex and acromial thoracic arteries.

The **Posterior Circumflex** is a large vessel, and is given off opposite the lower border of the subscapularis. It passes backwards with the circumflex veins and nerve through the quadrangular space, the boundaries of which have just been given. It winds round the neck of the humerus to supply the deltoid and shoulder joint, anastomosing with the anterior circumflex, supra-scapular and acromial thoracic arteries. It also supplies part of the teres minor and the long head of the triceps, and gives cutaneous twigs to the skin of the back of the shoulder.

The **Circumflex Nerve** accompanies the posterior circumflex artery, and arises from the posterior cord of the brachial plexus usually in common with the musculo-spiral. It is behind the axillary artery and in front of

the subscapularis, at the lower border of which it passes back and out, and before dividing into its two branches gives off an *articular* filament to the under part of the shoulder joint.

The *upper branch* winds round the humeral neck with the posterior circumflex vessels under the deltoid to its anterior border. It supplies this muscle, and gives off cutaneous filaments, which pierce it to supply the skin.

The *lower branch* at its origin gives filaments to the back of the deltoid and to the teres minor. The branch to the latter muscle usually has a reddish gangliform enlargement. The nerve then pierces the deep fascia, and supplies the skin over the lower two-thirds of the back of the deltoid and over the long head of the triceps.

Variety.—Turner has twice noticed a branch from the circumflex to the teres major.

Directions.—Before removing the fascia from the back of the scapula, the attachments of the infra-spinous aponeurosis must be made out. It is a strong fibrous membrane investing the infra-spinous muscle, and attached to the margin of the infra-spinous fossa. By its inner surface it gives origin to some fibres of that muscle, and also furnishes intermuscular septa which separate the infra-spinatus from the teres minor and the latter from the teres major. It is continuous externally with the deep fascia of the arm. Remove this aponeurosis to expose the infra-spinatus and teres major and minor muscles.

The **Infra-spinatus** muscle occupies the greater part of the infra-spinous fossa, and is triangular with its apex at the humerus. It arises by fleshy fibres from the inner two-thirds of the infra-spinous fossa, and by tendinous laminæ from the ridges on its surface; also from the infra-spinous aponeurosis. The neck, lower angle and inferior border of the scapula do not give origin to the infra-spinatus, but some of its fibres arise from the lower surface of the scapular spine and overlap its tendon, which glides over the external border of the spine of the scapula, crosses the upper and back part of the shoulder capsule, and is inserted into the middle facet on the greater tuberosity of the humerus, joining the tendons of the supra-spinatus and teres minor. There is sometimes a bursa between this muscle and the outer border of the spine of the scapula which communicates with the shoulder joint.

Relations.—*Posteriorly*, with the deltoid, trapezius, latissimus dorsi and skin. *Anteriorly*, with the scapula, from which it is separated by the supra-scapular and dorsalis scapulæ muscles, and with the shoulder joint. Its *upper border* is in contact with the scapular spine, and its *lower border* with the teres minor, being sometimes blended with it and with the teres major.

Action.—The arm being pendent, it is an external rotator, and when the arm is raised it helps to keep it in that position and with the hinder portion of the deltoid to carry it backwards.

Nerve.—The supra-scapular.

Varieties.—It is sometimes part of or intimately connected with the teres minor.

The **Teres Minor** is a longish narrow muscle along the inferior costa of the scapula. It arises from a narrow oblique groove on the posterior surface of the axillary border of the scapula, and from the intermuscular septa

and the infra-spinous aponeurosis, and is inserted by a tendon into the lowermost facet of the great tuberosity of the humerus, and by fleshy fibres for about an inch into the humerus immediately below it. Its tendon is in contact with the posterior and inferior part of the shoulder capsule.

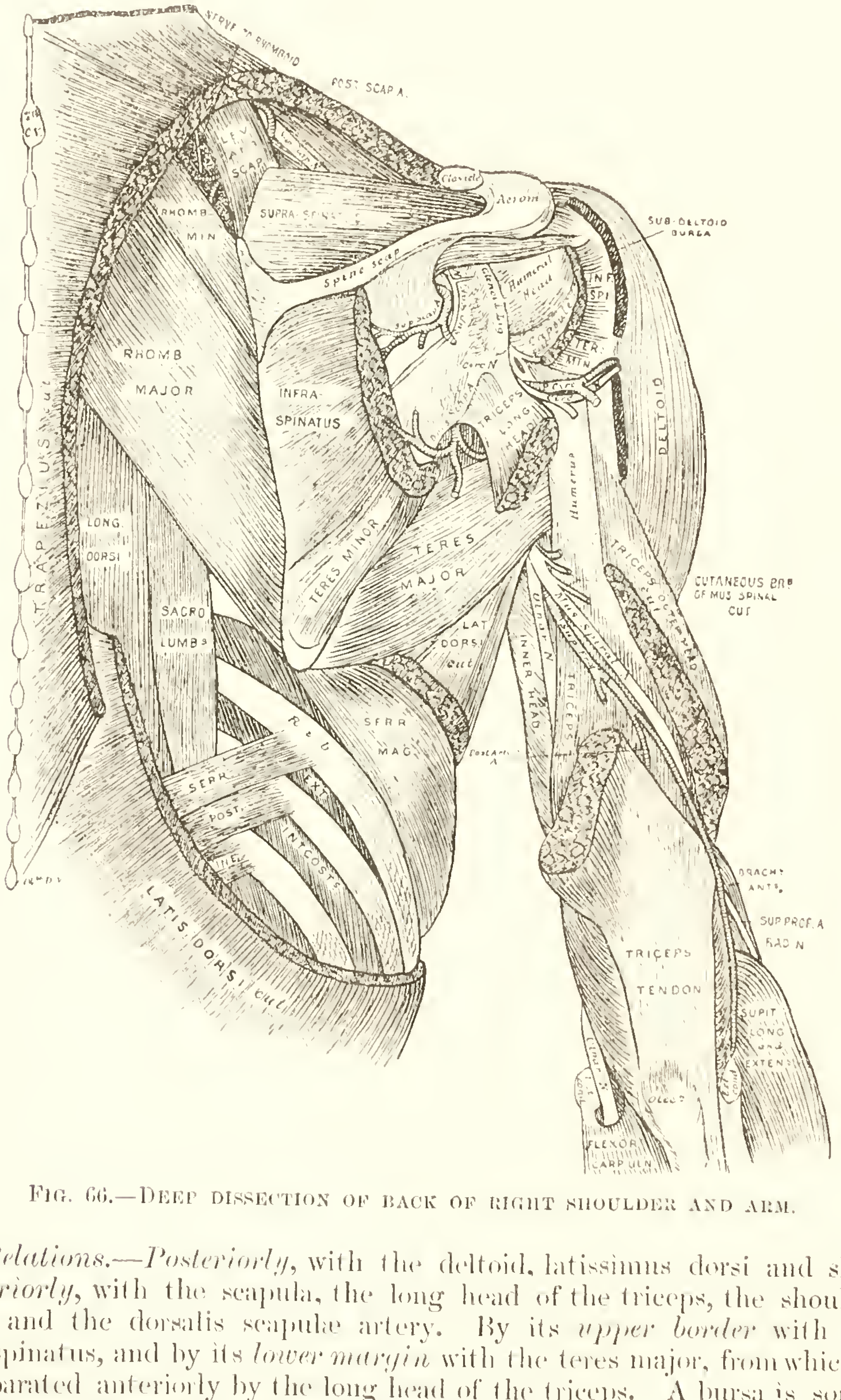


FIG. 66.—DEEP DISSECTION OF BACK OF RIGHT SHOULDER AND ARM.

Relations.—Posteriorly, with the deltoid, latissimus dorsi and skin. *Anteriorly*, with the scapula, the long head of the triceps, the shoulder joint and the dorsalis scapulæ artery. By its *upper border* with the infraspinatus, and by its *lower margin* with the teres major, from which it is separated anteriorly by the long head of the triceps. A bursa is sometimes present between the tendon and the bone.

Action.—With the arm hanging it is an external rotator, and it also moves the bone backwards. With the arm raised it will assist the infra-spinatus in keeping it in position or in depressing it.

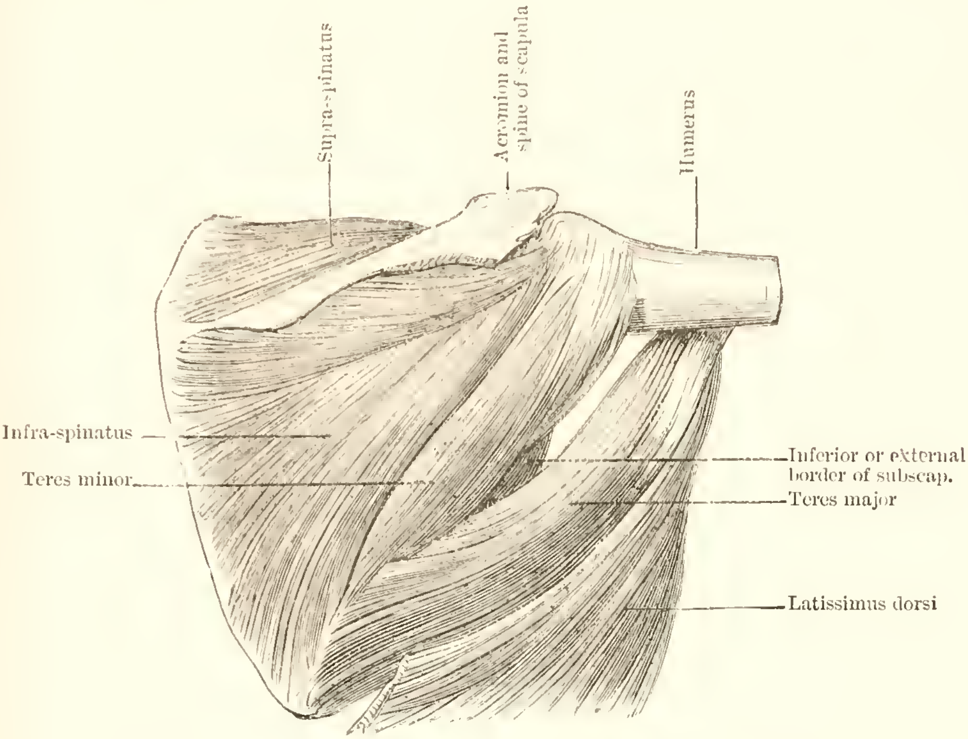


FIG. 67.—RIGHT SCAPULAR MUSCLES. POSTERIOR ASPECT.

Nerve.—The circumflex.

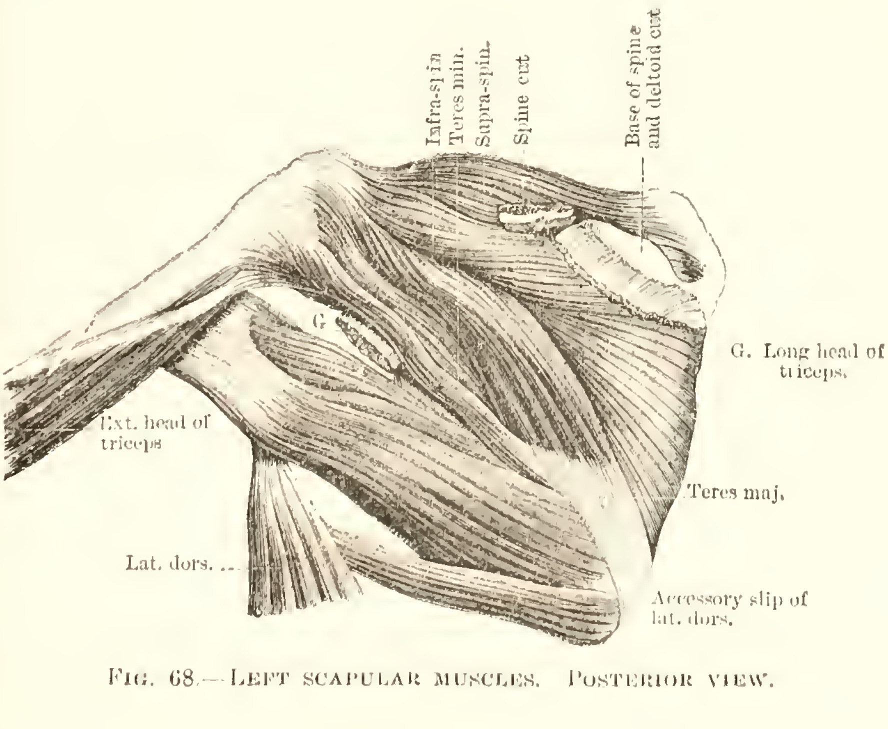


FIG. 68.—LEFT SCAPULAR MUSCLES. POSTERIOR VIEW.

The **Teres Major** is broader and flatter, and arises from a rough surface on the dorsal aspect of the inferior angle of the scapula and from the intermuscular aponeurosis. Its fibres are longitudinal and twist upon themselves to be inserted by a flat tendon about two inches wide and long, partly into and partly behind the inner bicipital ridge. At its insertion the tendon is behind that of the latissimus dorsi, with which it is partly blended. There is sometimes a bursa separating these muscles above at their insertion, and another bursa between the tendon and the bone. This muscle and the latissimus dorsi give off a tendinous expansion to the deep fascia of the arm.

Relations.—Anteriorly, with the subscapularis, latissimus dorsi, coraco-brachialis and short head of the biceps, axillary vessels and brachial plexus of nerves. *Posteriorly*, it is separated from the skin by the latissimus

FIG. 69.—ATTACHMENTS OF THE RIGHT SCAPULAR MUSCLES. POSTERIOR VIEW.

9. Transverse ligament of scapula with sections of supra-scapular vessels above, and the nerve beneath it. 10. Coraco-clavicular ligaments. Most of the ossific points of the scapula are also shown.

dorsi in front and long head of the triceps behind. Its *upper border* is separated from the teres minor by the long head of the triceps, and its *lower border* forms with the latissimus dorsi part of the posterior wall of the axilla. The *upper and inner border* of this muscle forms the lower boundary of a triangular space, of which the base is at the upper part of the humerus, and the other side the axillary costa of the scapula, which is covered in front by the subscapularis and behind by the teres minor muscles. The long head of the triceps divides this triangle into an upper or outer quadrangular space, and a lower or inner triangular interval. Through the quadrilateral space, which is bounded *above* by the teres minor, *below* by the teres major, *outside* by the humerus, *inside* by the long head of the triceps, pass the posterior circumflex vessels and the circumflex nerve; and through the triangular space, which is bounded *above*

by the teres minor, *below* by the teres major, and *outside* by the long head of the triceps, the dorsalis scapulæ artery passes.

Action.—The limb being pendent it acts as an internal rotator, and draws the arm backwards. The arm being raised the muscle adducts and depresses it. This and the two preceding muscles will, if the humerus be fixed, draw the scapula towards it, the teres major causing the lower angle of the scapula to move forwards, rotating the scapula on the rib on an antero-posterior axis.

Nerve.—It is supplied by the middle and long subscapular nerves.

Varieties.—This muscle sometimes has fasciculi of connection with the latissimus dorsi, coming from some part of the scapula, and occasionally a slip from it has been seen descending on the deep fascia of the upper arm externally.

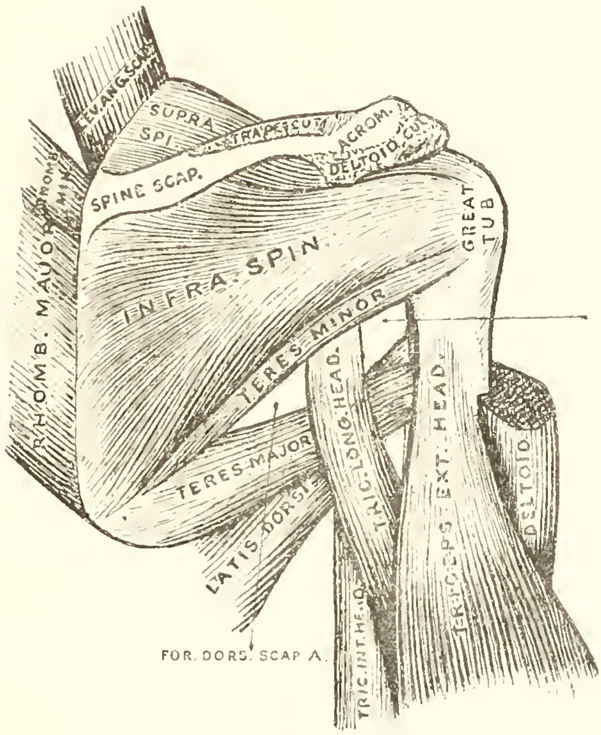


FIG. 70.—SCAPULO-HUMERAL MUSCLES. POSTERIOR VIEW.

Dissection.—The ligaments connecting the clavicle and scapula must be examined before proceeding to the examination of the supra-spinatus muscle, and to expose them the remaining fibres of the trapezius and deltoid muscles and the areolar tissue must be removed.

Scapulo-Clavicular Ligament and *Articulation.*—This joint is formed by the outer end of the clavicle and the upper edge of the acromion process of the scapula. The clavicle is joined to the scapula by this articulation, and by the strong coraco-clavicular ligament. The scapulo-acromial joint possesses a superior and inferior acromio-clavicular ligament and an inter-articular fibro-cartilage.

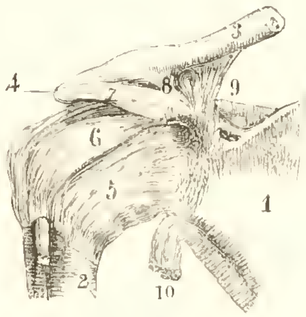
The *Superior Acromio-Clavicular Ligament* is a square broad band covering the upper part of the joint, being attached to the clavicle at the upper part of its outer end, and to the upper part of the acromion. Its fibres are parallel and interlaced with the aponeurosis of the deltoid and

trapezius. Its inner surface is in contact with the margin of the inter-articular fibro-cartilage and with the synovial membrane.

The *Inferior Acromio-Clavicular Ligament* is thinner than the Superior, and is on the under-surface of the joint, being attached to the adjoining surfaces of the clavicle and the acromion. Its upper surface is in contact with the fibro-cartilage (if it be present) and the synovial membrane; its under-surface with the tendon of the supra-spinatus. The superior and inferior ligaments are tendinous in front and behind the joint, and really form a complete capsule to it.

The *Inter-Articular Fibro-Cartilage* is often present between the bones at the upper part of the joint; occasionally it completely separates the joint into two cavities. In the latter case there are two synovial membranes. In two old people I have seen the acromion and clavicle united by fibro-cartilage. This may have been normal to them, or possibly the result of arthritis. When present the fibro-cartilage is wedge-shaped and its base is attached to the upper ligament.

Movements.—These are of two kinds, a gliding of the clavicle on the acromion to and fro and up and down, and a rotation of the scapula



1. Scapula.
2. Humerus.
3. Clavicle.
4. Margin of acromion.
5 and 6. Bands of the capsular ligament.
7. Coraco-acromial ligament.
8. Conoid.
9. Trapezoid ligament.
10. Long head of triceps,

FIG. 71.—RIGHT ACROMIO-CLAVICULAR AND CORACO-ACROMIAL LIGAMENTS.

backwards and forwards on the clavicle. In this latter movement the acromion moves from above down at the fore part of the joint, and from below up at the back; but if the acromion be elevated the surfaces move in the opposite direction. The extent of rotation is limited by the two portions (trapezoid and conoid) of the coraco-clavicular ligament.

Vessels and *Nerves.*—These come from the supra-scapular artery and nerve and the acromio-thoracic artery.

The clavicle is also connected to the scapula by a strong ligament, the coraco-clavicular. This ligament consists of two parts, the trapezoid and conoid, having different directions.

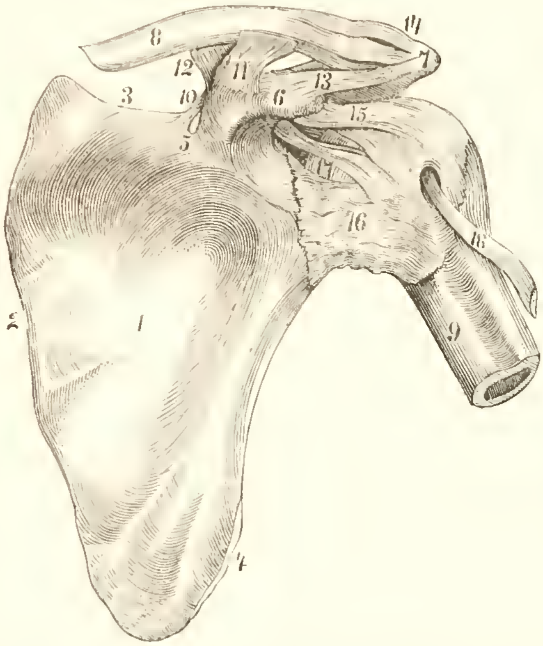
The *Anterior* and *External* fasciculus, the *trapezoid* ligament, is larger than the conoid, and is broad, thin, and quadrilateral, and passes obliquely from the coracoid process to the clavicle. It is attached below to the upper surface and inner border of the coracoid process along the hinder half; and above to the oblique line on the under-surface of the clavicle, which passes outwards from its tubercle. Its anterior border is free, but its posterior border is joined to the conoid.

The *Conoid Ligament* is the *internal* and *posterior* fasciculus, and is a strong conical band having its base upwards. Below, it is attached by its apex to a rough depression at the posterior and inner part of the base of

the coracoid process, and above by its base to the conoid tubercle on the under-surface of the clavicle and to a line passing from it inwards for half an inch. In front of this ligament is the subclavius muscle, and behind is the trapezius. They check forward and backward rotation of the scapula. The two bands of this ligament are joined below posteriorly, but are separated in front, forming an angle.

Special Ligaments of the Scapula.—The ligaments proper to the scapula are the coraco-acromial or deltoid ligament, the transverse, suprascapular or coracoid ligament, and the spino-glenoid ligament.

The *Coraco-Acromial Ligament* is sometimes called the *anterior ligament* of the scapula, and is a broad flat triangular band, passing transversely between the acromion and coracoid processes above the



1. Scapular venter.
2. Vertebral border.
3. Superior border.
4. Axillary border.
5. Supra-scapular notch.
6. Coracoid process.
7. Acromion.
8. Clavicle.
9. Humerus.
10. Transverse lig.
11. Trapezoid ,,
12. Conoid ,,
13. Coraco-acromial.
14. Sup. and inf. acro-clav.
15. Coraco-humeral.
16. Capsular.
17. Opening for subscap. bursa.
18. Long tendon of biceps.

FIG. 72.—SCAPULO-HUMERAL AND SCAPULO-CLAVICULAR LIGAMENTS. ANTERIOR ASPECT.

shoulder joint. It is fixed by its broad base to the whole length of the outer border of the coracoid process and reaches to the shoulder capsule, and by its apex to the point of the acromion process immediately in front of the acromio-clavicular articulation. It consists of an anterior and posterior band with a thin intervening portion. The anterior part passes transversely, and the posterior obliquely, back and out. The coracoid and acromion processes, and coraco-acromial ligaments, form an arch above the head of the humerus which protects the shoulder and checks the ascent of the humeral head. *Above* it are the clavicle and the under-surface of the deltoid. *Below* is the tendon of the supra-spinatus, a bursa intervening. Its *anterior border* is continuous with the strong cellular layer that passes beneath the deltoid over the tendons of the supra- and infraspinous muscles. Its *posterior border* is in relation with the supraspinatus.

The *Transverse, Coracoid* or *Posterior Ligament* is a thin, flat, fibrous band, narrower at the middle than at the attachments, and is fixed at one

end to the base of the coracoid process and at the other to the inner end of the upper border behind the notch. It converts the supra-scapular notch into a foramen, through which the supra-scapular nerve passes, the supra-scapular vessels going above it. I have seen the vein passing beneath the ligament when the artery went above. Sometimes all these structures pass beneath, and occasionally they change places.[1]

Dissection.—Saw through the acromion process and pull it and the outer end of the clavicle aside, and after making out the attachments of the supra-spinous aponeurosis, this may be removed to study the supra-spinatus muscle.

The *Supra-Spinatus Aponeurosis* or *Fascia* is a thick and strong layer completing the osseo-fibrous case which encloses the supra-spinatus. It is thick internally, but under the coraco-acromial ligament it is thinner, and is attached to the margins of the supra-spinous fossa.

The **Supra-Spinatus Muscle** is triangular, and its base arises from the inner two-thirds of the supra-spinous fossa and from the deep surface of the supra-spinatus aponeurosis. It passes beneath the acromion and is inserted at its apex by a tendon which crosses the upper part of the shoulder capsule, with which it is intimately blended, into the highest facet on the great tuberosity of the humerus, being connected with the tendon of the infra-spinatus.

Relations.—*Superiorly*, with the clavicle, acromion, coraco-acromial ligament, trapezius and deltoid. *Inferiorly*, with the scapula, upper part of the shoulder joint and supra-scapular vessels and nerve.

Action.—It assists the deltoid in raising the arm from the side, and it supports the head of the humerus in the glenoid cavity. It tends to prevent displacement of the humeral head upwards.

Nerve.—Supra-scapular.

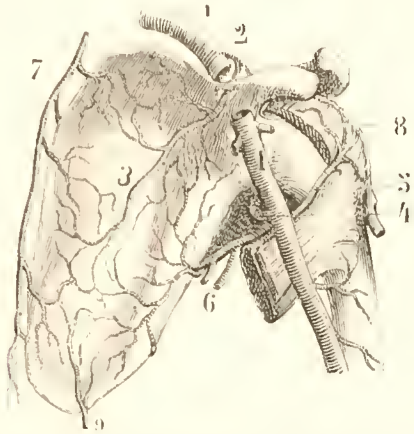
Dissection.—Detach the supra- and infra-spinatus muscles near the base of the scapula, and carefully throw them outwards, so as to preserve the supra-scapular vessels and nerve, and their branches, which are to be traced beneath the acromion to the infra-spinous fossa. Beneath the teres minor will be found the dorsalis scapulæ and the anastomoses between it, the supra-, infra-, and posterior scapular arteries must be traced out.

The **Supra-Scapular Artery** is given off from the thyroid axis of the subclavian. It crosses the root of the neck obliquely from within outwards, and passes over the transverse ligament of the scapula to the supra-spinous fossa, ramifying between it and the supra-spinatus, which it supplies, giving off a branch which crosses the scapular neck to reach the infra-spinous fossa and anastomose with the dorsalis scapulæ. It gives off a supra-acromial branch, which pierces the trapezius, supplies the skin over the acromion, and anastomoses with the acromio-thoracic. Beneath the supra-spinatus a supra-spinal branch from it supplies the muscle, the supra-spinous fossa, and the upper part of the shoulder joint; and as the vessel crosses the transverse ligament, a branch enters the subscapular fossa beneath the subscapularis, and anastomoses with the subscapular

[1] There is frequently a strong ligamentous band extending from the outer part of the curved edge of the spine of the scapula to the upper part of the glenoid margin, where it blends with the capsular ligament. This is the *spino-glenoid* ligament. The *coraco-glenoid*, extending from the coracoid process to the capsular ligament, is often present. It arises with the coraco-humeral (*Macalister*).

from the axillary, and posterior scapular from the subclavian. The supra-scapular vein enters into the external jugular.

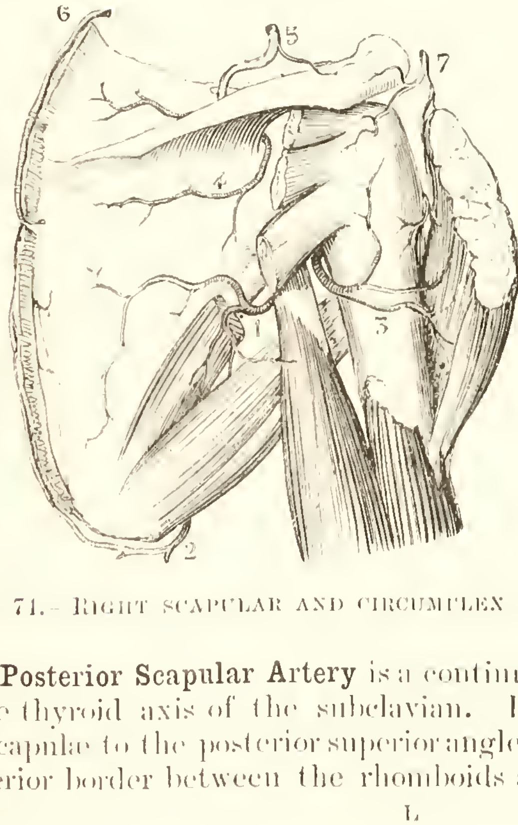
The *Supra-Scapular Nerve* comes from the fifth, sixth, and seventh cervical nerves, and is a branch of the brachial plexus given off above the clavicle. It passes obliquely outwards beneath the trapezius, enters the supra-spinous fossa beneath the transverse ligament, giving two branches



1. Second part of subclavian cut, the cut axillar beyond it.
2. Supra-scapular.
3. Its anastomoses with dorsalis scapulæ, posterior scapular, and infra-scapular.
4. Posterior circumflex.
5. Anterior circumflex.
6. Dorsalis scapulæ.
7. Posterior scapular.
8. Acromio-thoracic, cut.
9. Infra-scapular.

FIG. 73.—ANASTOMOSES OF THE SCAPULAR ARTERIES. ANTERIOR VIEW.

to the supra-spinatus and filaments to the shoulder joint. It then passes beneath the supra-spinatus, curving round the outer border of the scapular spine beneath a fibrous band (the spino-glenoid ligament) to the infra-spinous fossa, where it gives two branches to the infra-spinatus and some filaments to the shoulder joint and scapula.



1. Dorsalis scapulæ.
2. Its infra-scapular branch.
3. Posterior circumflex.
4. Termination of supra-scapular.
5. Supra-scapular.
6. Posterior scapular.
7. Ending of acromio-thoracic. The quadrangular and triangular spaces formed by the two teres and long head of triceps are also shown. The supra- and infra-spinatus, deltoid, and middle head of triceps are cut.

FIG. 74.—RIGHT SCAPULAR AND CIRCUMFLEX ARTERIES. POSTERIOR VIEW.

The **Posterior Scapular Artery** is a continuation of the transversalis colli from the thyroid axis of the subclavian. It passes beneath the levator anguli scapulæ to the posterior superior angle of the scapula, passing along its posterior border between the rhomboids and serratus magnus, supply-

ing them and part of the latissimus dorsi, trapezius and scapula. It anastomoses with the supra-, sub- and infra-scapular arteries, and with the posterior branches of some of the upper intercostals.

The **Dorsalis Scapulæ Branch** of the subscapular artery runs back below the axillary border of the scapula in the triangular space between it and the teres muscles. It enters the infra-spinous fossa beneath the teres minor, supplying it and the infra-spinatus, and anastomosing with the supra-scapular artery. Its infra-spinous branch runs between the teres muscles to the inferior angle of the bone, and anastomoses with the posterior scapular.

THE FRONT OF THE ARM.

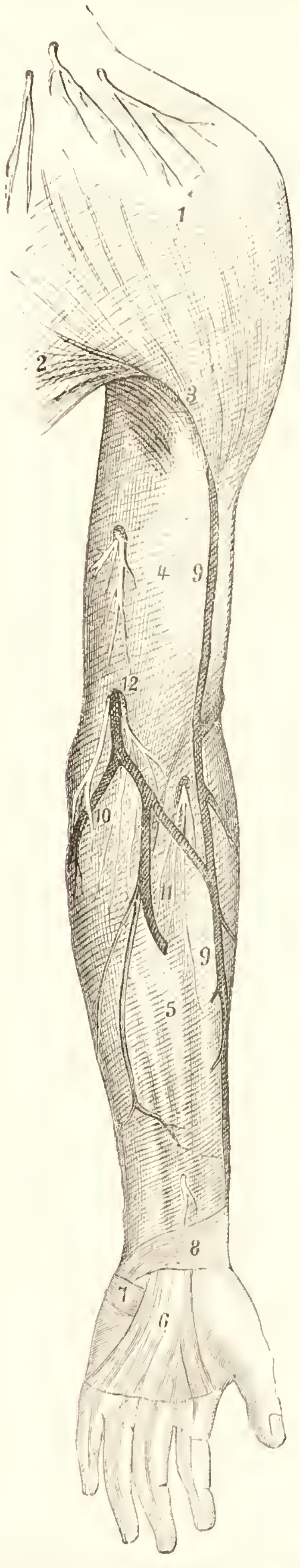
Directions.—The limb should lie with the palm of the hand and biceps uppermost.

Dissection.—Raise the skin by making an incision in continuation with the previous one as far as two inches below the elbow, at the end of which another incision transverse to it is to be made across the forearm. Reflect the skin out and in, and observe the subcutaneous bursa between it and the olecranon. In the superficial fatty fascia seek the cutaneous vessels and nerves. The superficial fascia with fat between its layers is thicker in front of the elbow, where it encloses the superficial vessels, nerves and lymphatics, than in other parts of the arm.

Position of Cutaneous Nerves.—Two external cutaneous branches of the musculo-spiral will be found about the middle of the outer side of the arm, and just below the elbow, external to the biceps tendon, is the cutaneous portion of the musculo-cutaneous nerve. The inner cutaneous nerves are more numerous, the internal cutaneous being by the side of the basilic vein about the middle of the arm, and a small offset from it to the skin pierces the fascia higher up, somewhat external to this nerve. In the lower third of the arm will be found the nerve of Wrisberg, and in the upper third are the intercosto-humeral, and the internal cutaneous from the musculo-spiral. It forms an investment for the arm, and is continuous with the superficial fascia of the shoulder, thorax, and forearm.

Position of the Cutaneous Veins.—Just below the bend of the elbow there are several cutaneous veins. The median vein is in the centre of the forearm, and bifurcates somewhat below the elbow bend. On its inner side are the anterior and posterior ulnar veins, which unite into one, and on its outer side is the small radial vein. The outer branch of the median joins the radial vein to form the cephalic vein (median cephalic), which runs along the outer side of the biceps. The vein resulting from the union of the two ulnar veins is joined by the inner branch of the median (median basilic), which is longer than the median cephalic, to form the basilic vein.

The *Median Cephalic Vein* passes obliquely out in the hollow between the biceps and the extensors and supinators of the forearm. Some small cutaneous twigs of the musculo-cutaneous pass over it, and the trunk of the nerve runs beneath it. It is generally smaller than the median basilic, and is quite away from the brachial artery. It has not generally



1. Deltoid fascia.
2. Pectoral fascia.
3. Brachial arch.
4. Brachial fascia.
5. Antibrachial fascia.
6. Palmar fascia.
7. Palmaris brevis.
8. Ant. annlr. lig.
9 9. Cephalic vein.
10. Basilic vein.
11. Median vein.
12. Opening for basilic vein and int. cut. nerve. Opening for nerve of Wrisberg on inner side of **4**, and for ext. cut. to inner side of cephalic vein. Just above annlr. lig. is the palmar branch of median nerve. The acromial and clavicular branches of the cervical plexus are shown.

FIG. 75.—DEEP FASCIÆ OF LEFT ARM AND FOREARM, ONE-FIFTH, SHOWING WHERE SOME OF THE CUTANEOUS NERVES PIERCE IT. ANTERIOR ASPECT, THE HAND SUPINATED.

been opened in venesection, because its position in the groove between the muscles makes compression of it somewhat difficult and uncertain.

The *Median Basilic Vein* is more horizontal than the preceding, and crosses to the inner side of the limb between the biceps and pronator radii teres over the brachial artery. The deep fascia of the arm and the bicipital fascia separate it from the brachial artery. It is larger than the median cephalic. Some cutaneous twigs of the internal cutaneous nerve are over it and larger branches of the same nerve behind it.

FIG. 76. SUPERFICIAL VEINS OF THE RIGHT FOREARM AND RELATIONS OF BRACHIAL ARTERY AT ELBOW, TWO OPENINGS HAVING BEEN MADE IN THE DEEP FASCIA.

10, Bicipital fascia and intercrossing of its fibres with the deep fascia.

This vein is generally selected to bleed from because it is usually larger, more superficial, and more readily compressed; but, as it crosses the brachial artery, it should be opened in a part which is away from that vessel.

The *Basilic Vein* is of large size, and formed by the union of the anterior and posterior ulnar veins, and, commencing near the inner condyle, ascends with the brachial artery to end either in one of the venæ comites of the brachial or to be continuous with the axillary vein.

The *Cephalic Vein* comes mainly from the outer or median cephalic branch of the median, the radial vein being frequently very small. It

ascends on the outer side of the biceps, and at the upper third of the arm is between the pectoralis major and the deltoid, accompanied by the descending branch of the acromial thoracic artery and the upper external cutaneous branch of the musculo-spiral nerve, and ends just below the clavicle, between it and the coracoid process, in the axillary vein after piercing the costo-coracoid membrane. Sometimes this vein joins the external jugular or subclavian by a branch passing over or under the clavicle, and in some rarer instances this communicating branch may pierce the clavicle, accompanied by a small artery. There is usually a venule uniting this vein with the basilic or with the vein which joins the basilic just below the middle of the arm.

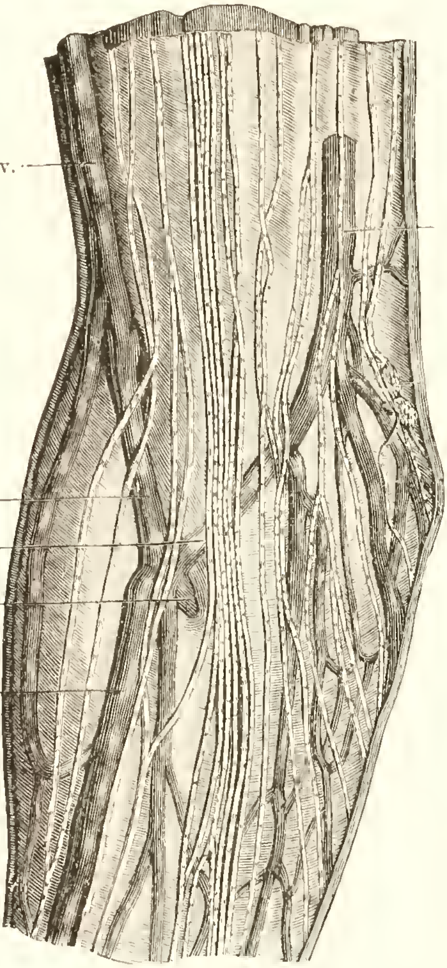


FIG. 77.—SUPERFICIAL VEINS AND LYMPHATICS AT FRONT OF RIGHT ELBOW. THE DEEP FASCIA IS SHOWN BENEATH THE VESSELS.

Varieties.—This vein often ends with the external jugular above or below the clavicle. The jugulo-cephalic is (when present) the branch of communication between this and the subclavian veins.

The *Veins of the Upper Arm are Superficial and Deep.*—The most important of the former veins of the arm are those which have been described. Many others which are innominate will be observed by a careful dissector, and will be seen to form free anastomoses between them-

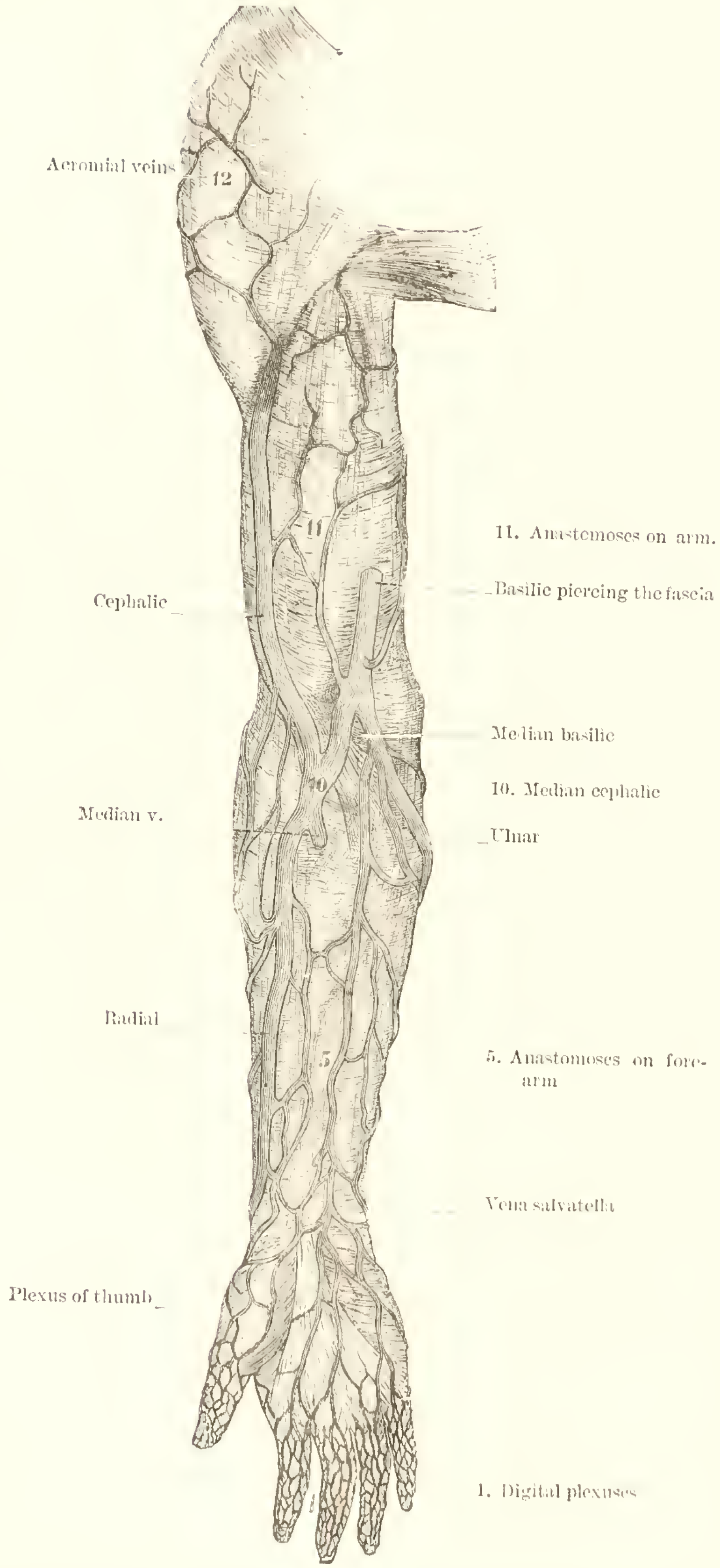


FIG. 78.—THE SUPERFICIAL VEINS OF THE ANTERIOR ASPECT OF THE RIGHT UPPER LIMB, SHOWING THE DIGITAL PLEXUSES AND THE DEEP FASCIA.

selves, and here and there with the deep veins through the deep fascia. The superficial veins are much larger than the deep, and anastomose freely

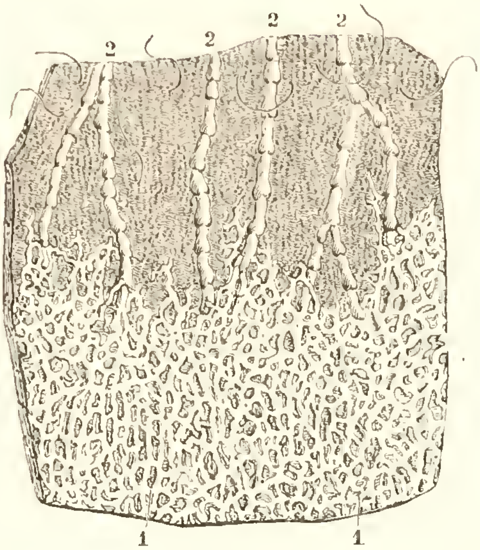


FIG. 79.

1. Subcutaneous lymphatic plexuses. 2. Lymphatic trunks (injected).

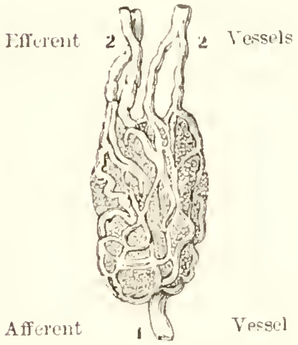


FIG. 80.

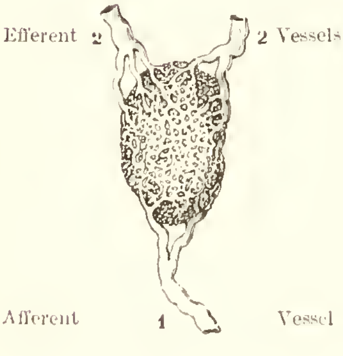


FIG. 81.

FIG. 82.—SHOWING THE VALVES IN THE LYMPHATIC TRUNK.

with the deep, especially in the neighbourhood of joints. This frequent junction ensures the venous circulation of the limb during muscular action when the deep veins are pressed on.

The *Deep Veins* are smaller, and accompany the arteries forming their venæ comites, and lie with them beneath the deep fascia. There are

FIG. 83.—SUPERFICIAL LYMPHATICS OF LEFT ARM.

1. Supracondyloid gland. The axillary glands are shown.

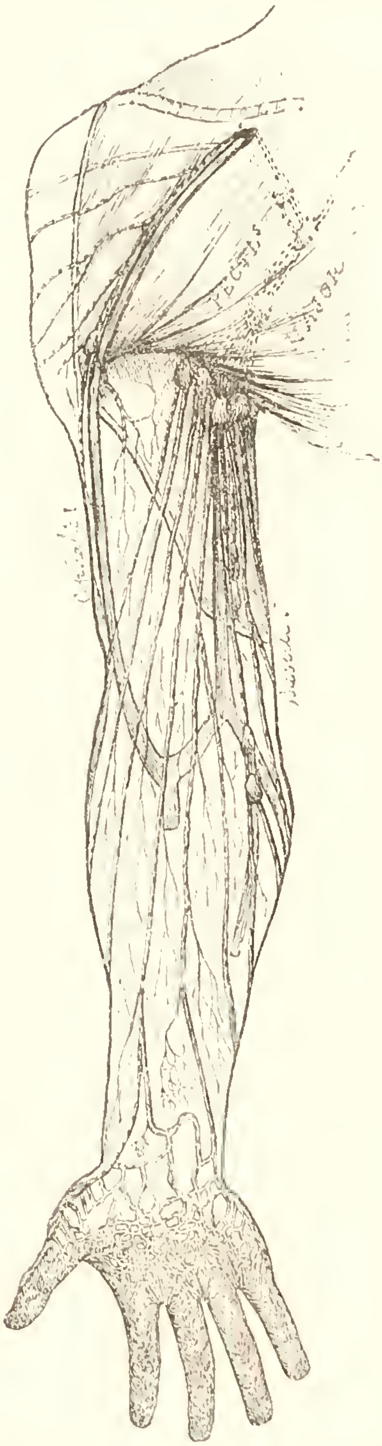


FIG. 84. SHOWING THE DIGITAL PLEXUSES AND THE RELATIONS TO THE SUPERFICIAL VEINS. RIGHT ARM.

generally two of them, one on each side of the corresponding artery, and at intervals they are connected by short transverse branches before and

behind the artery; both superficial and deep veins have valves, these being more numerous in the deep than in the superficial.

The *Lymphatic Vessels and Glands* of the upper extremity are, like the veins, arranged into superficial and deep sets. The superficial lymphatics of the arm lie mostly along the basilic vein and empty into the axillary glands. Some outer lymphatics accompany the cephalic vein, and empty mostly into the subclavian lymphatic glands. A few, however, cross the upper part of the biceps, and end in the anterior axillary glands.

The *Superficial Lymphatic Glands* of the arm are very few and of small size. One, two, or three may be found in front of the elbow, and one or two rather more than an inch above the inner humeral condyle near the basilic vein.

The *Deep Lymphatics* of the arm communicate at intervals with the superficial, and pass through the deep lymphatic glands which run up along the brachial artery. They enter the axillary and subclavian glands, and on the right side end in the right lymphatic duct, on the left in the thoracic duct.

Cutaneous Nerves.—All the superficial nerves of this region, with one exception (the intercosto-humeral), come from the brachial plexus either as distinct branches or are given off from the nerves into which it divides. On the outer side are filaments of the external cutaneous and musculo-spiral, and on the inner are a large and small internal cutaneous (from the plexus), an internal cutaneous branch of the musculo-spiral, and the intercosto-humeral from the second intercostal nerve.

Internal Cutaneous Nerves.—The *Internal Cutaneous Nerve* is the inner smallest branch of the brachial plexus. It is given off from the inner cord with the inner head of median and ulnar, and is on the inner side of the brachial artery. It pierces the deep fascia near the basilic vein, and becoming cutaneous divides into two branches, anterior and posterior.

Near the axilla it gives off a cutaneous filament which lies a little external to the nerve from which it comes, pierces the fascia, and innervates the skin over the biceps almost as far as the elbow.

The *Anterior Branch* is the larger, and is usually in front of the median basilic vein, but is sometimes behind it. It will be traced in the forearm in a subsequent dissection.

The *Posterior Branch* runs obliquely down on the inner side of the basilic vein over the inner humeral condyle to the back of the forearm, where it will be dissected with that region. Above the elbow it joins the nerve of Wrisberg.

The *Lesser Internal Cutaneous Nerve* (or nerve of Wrisberg) supplies the skin on the inner side of the arm. It is the smallest branch of the plexus, and is given off from the inner cord usually with the internal cutaneous and ulnar nerves. In the axilla it is at first behind, and then on the inner side of the axillary vein, where it joins the intercosto-humeral. In the arm it is on the inner side of the brachial artery, and it pierces the deep fascia about its middle, and inclining backwards supplies the skin of the back and lower third of the arm as far as the elbow. Some filaments are given off from it between the olecranon and the inner condyle to the back of the former process, and others supply the skin in front of the inner condyle. It joins the inner branch of the internal cutaneous nerve.

The *Internal Cutaneous Branch* of the musculo-spiral nerve is given off in the axilla with the innermost muscular branch. It is small, and runs along the inner side of the arm, becoming subcutaneous on the upper third, to supply the skin on its posterior aspect nearly as far as the olecranon.

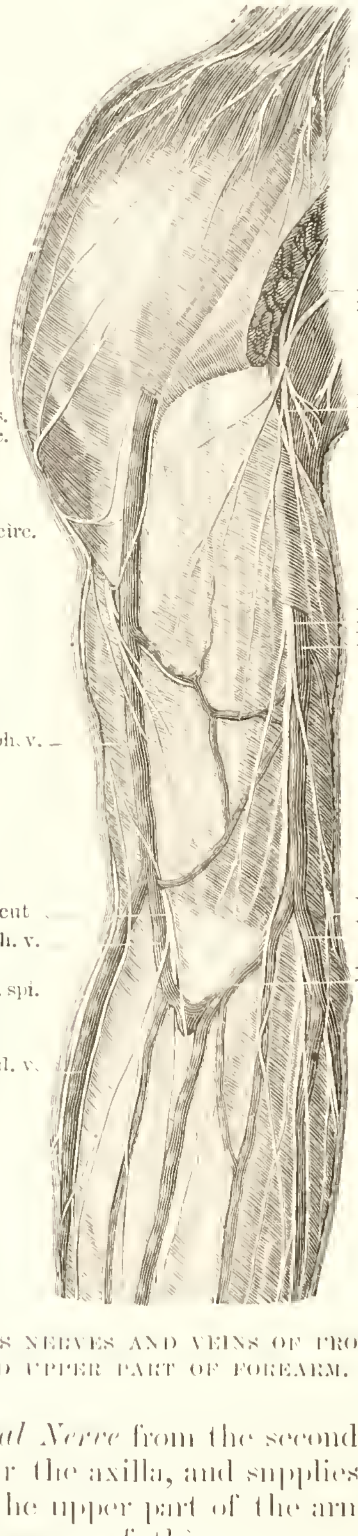


FIG. 85.—CUTANEOUS NERVES AND VEINS OF FRONT OF RIGHT ARM AND UPPER PART OF FOREARM.

The *Intercosto-Humeral Nerve* from the second intercostal pierces the deep fascia of the arm near the axilla, and supplies the skin on the inner and posterior surfaces of the upper part of the arm. The size and distribution, and even the presence, of this nerve may be modified by the

development of Wrisberg's nerve, and the inner cutaneous branch of the musculo-spiral.

External Cutaneous Nerves.—The cutaneous portion of the musculo-cutaneous nerve pierces the deep fascia a little above the front of the elbow on the outer side of the biceps tendon. It runs beneath the median cephalic vein, and divides into the anterior and posterior branch, which will be dissected with the forearm.

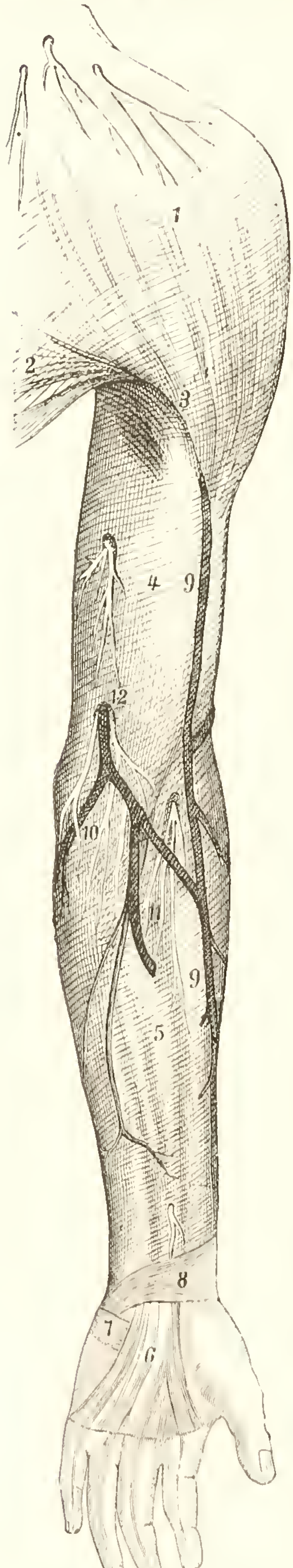
There are two external cutaneous branches of the musculo-spiral. The *upper* smaller one accompanies the cephalic vein to the front of the elbow, supplying the skin on the lower half of the anterior aspect of the arm; the *lower* larger branch pierces the deep fascia below the insertion of the deltoid, and passes down along the outer side of the arm and elbow to the radial side of the forearm, where it will be subsequently traced.

The *Deep Fascia* or *Aponeurosis* of the arm is a whitish glistening structure, which is continuous with that covering the deltoid and pectoral muscles. It is a thin, loose, membranous investment to the arm muscles, and from its deep surface sends processes and septa between them. It is composed of circular and spiral fibres, which are connected by vertical ones. It varies in thickness in different parts, and receives accessory fibres from the tendons of the pectoralis major, latissimus dorsi and deltoid which lie beneath it. Over the biceps it is thin, but thicker over the triceps and humeral condyles. Above it is attached to the outer part of the clavicle, the acromion, and the scapular spine; and below it is continuous with the deep fascia of the forearm, and is attached to the bony prominences about the elbow, and especially to the humeral condyloid ridges. Two processes, more strongly marked than the rest, separate the muscles of the anterior from those of the posterior brachial regions. The outer of these is the *external intermuscular septum*, and extends along the external condyloid ridge from the lower part of the anterior bicipital ridge to the outer condyle. The tendon of the deltoid blends with it, and the outer portion of the brachialis anticus, supinator longus, and extensor carpi radialis longior, partly arise from it in front, and the outer head of the triceps partly has origin from its posterior surface. It is pierced by the superior profunda artery and musculo-spiral nerve. The *internal intermuscular septum* is thicker than the external, and is attached along the inner condyloid ridge from the lower part of the posterior bicipital lip below the teres major, to the inner condyle. The tendon of the coraco-brachialis blends with it, the inner portion of the brachialis anticus partly arises from it in front, and the inner head of the triceps is attached to it posteriorly. It is perforated by the inferior profunda and anastomotica magna vessels and the ulnar nerve.

Directions.—Tie together, in their natural position, the vessels and nerves at the upper part of the limb, and attach them to the coracoid process. Raise the scapula, and render tense the muscles by fixing them in a suitable position.

Dissection.—Remove the deep fascia or aponeurosis by incisions similar to those through the skin, and reflect it out and in.

Anterior Humeral Muscles.—There are three muscles on the front of the arm—that in the centre being the biceps, that in the inner side the coraco-brachialis, and that beneath the lower part of the biceps the brachialis anticus. The flexor and pronator muscles of the forearm arise from



1. Deltoid fascia.
2. Pectoral fascia.
3. Brachial arch.
4. Brachial fascia.
5. Antibrachial fascia.
6. Palmar fascia.
7. Palmaris brevis.
8. Ant. Annlr. lig.
9 9. Cephalic vein.
10. Basilic vein.
11. Median vein.
12. Opening for basilic vein and int. cut. nerve. Opening for nerve of Wrisberg on inner side of 4, and for ext. cut. to inner side of cephalic vein. Just above annlr. lig. is the palmar branch of median nerve. The acromial and clavicular branches of the cervical plexus are shown.

FIG. 86.—DEEP FASCIÆ OF LEFT ARM AND FOREARM, ONE-FIFTH, SHOWING WHERE SOME OF THE CUTANEOUS NERVES PIERCE IT. ANTERIOR ASPECT, THE HAND SUPINATED.

the inner humeral condyle, and the extensors and supinators from the outer.

The **Coraco-brachialis** is the smallest of these muscles, and is placed at the upper and inner part of the arm. It is roundish, and arises by fleshy fibres from the middle facet on the apex of the coracoid process, and from the tendinous short head of the biceps, which is immediately external to it; also from the intermuscular septum between them. Its fibres pass back, down, and out, and are inserted by a flat tendon into a rough ridge at the middle of the inner side of the humeral shaft, below the level of the deltoid, and between the inner origins of the triceps and brachialis anticus. An aponeurotic process passes up to the neck of the humerus from its insertion, and is joined by fleshy fibres. This process forms a sling over the latissimus dorsi tendon. The coraco-brachialis is pierced by the musculo-cutaneous nerve.

Relations.—Anteriorly, with the pectoralis major and deltoid above, and at its insertion with the brachial vessels and median nerve, which cross it. *Posteriorly*, with the tendons of the subscapularis, teres major and latissimus dorsi, the short head of the triceps, the humerus and the anterior circumflex vessels. *Internally*, with the median and musculo-cutaneous nerves and the brachial artery, to which its inner border is a guide for the upper part of the vessel. *Externally*, with the short head of the biceps and brachialis anticus.

Actions.—It adducts and draws forwards the arm, and if the humerus be fixed it will draw the scapula down and assist in keeping the shoulder-joint surfaces in contact.

Nerve.—The musculo-cutaneous.

Varieties.—It is subject to much variation, and Wood thinks that it consists typically of three parts: 1, an upper short one, arising from or near the coracoid process, and passing over the capsular ligament to be inserted just below the small humeral tuberosity; 2, a second portion, corresponding very nearly to the muscle as usually described; and 3, a third, which is the most superficial and the longest, and passes to or near the inner condyle, and in many cases is inserted into the supra-condyloid process when this is present. The second or middle division is, in man, the most constant, but is usually accompanied by a portion of the third, the external cutaneous nerve passing between them. All three slips are found in varying forms and degrees of development in lower vertebrates; but the first and third are the most marked peculiarities in man. Struthers has described a fibrous band connected with the inferior portion of this muscle, and has named it the *Internal Brachial Ligament.*

The **Biceps** is a long spindle-shaped muscle, wider in the middle than at the ends, and occupies the whole of the front surface of the arm, forming the prominence noticeable in front of it. It is divided into two tendinous portions or heads, of different lengths, whence its name. These both arise from the scapula. The short head takes origin by a thick flattened tendon from the middle facet near the apex of the coracoid process in common with the coraco-brachialis; and the long head arises by a long rounded bifurcated tendon, which is continuous with the upper margin of the glenoid cavity. This tendon pierces the capsular ligament, but is outside the synovial cavity of the joint, and arches over the head of the humerus, being enclosed in a reflection of the synovial membrane of the shoulder,

to which it is external, and on leaving the capsule it descends along the bicipital groove, in which it is retained by expansions from the pectoralis major, latissimus dorsi, and teres major. Muscular fibres come from each tendinous head, and form a narrow, flattened, fleshy

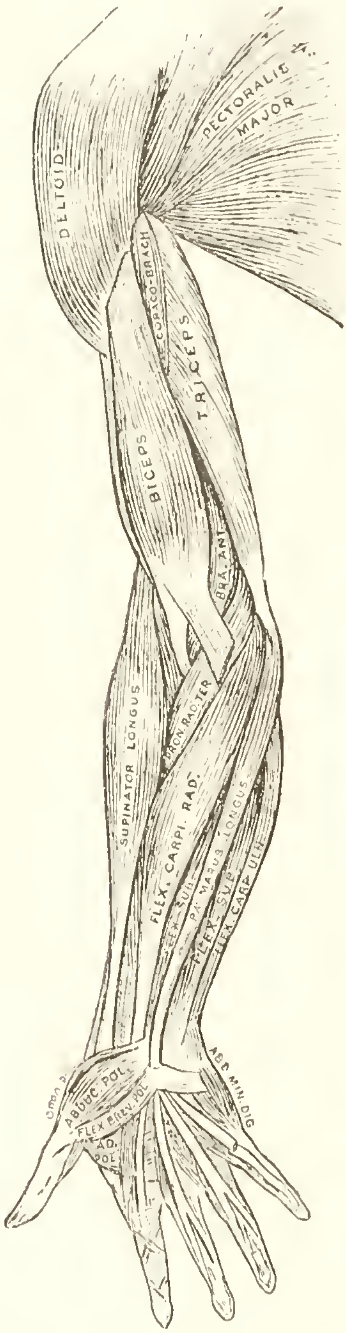


FIG. 87.—SUPERFICIAL MUSCLES OF THE FRONT OF THE RIGHT ARM AND FOREARM

belly about the middle of the arm, which ends just above the elbow in a flattened tendon which is inserted into the posterior part of the radial tuberosity, a synovial bursa being placed between the front of the tuberosity and the tendon. The tendon of insertion is broad, thin, and sharp externally, and near the radius it becomes narrow and twisted upon

itself, being applied by a flat surface to the tuberosity, so that its edges look backwards and forwards. Opposite the bend of the elbow a broad aponeurosis, called the *bicipital* or *semilunar fascia*, is given off from its inner side. This passes obliquely over the brachial artery downwards and inwards to be continuous with the deep fascia of the forearm. The connections of the long head and the tendinous insertions will be subsequently dissected.

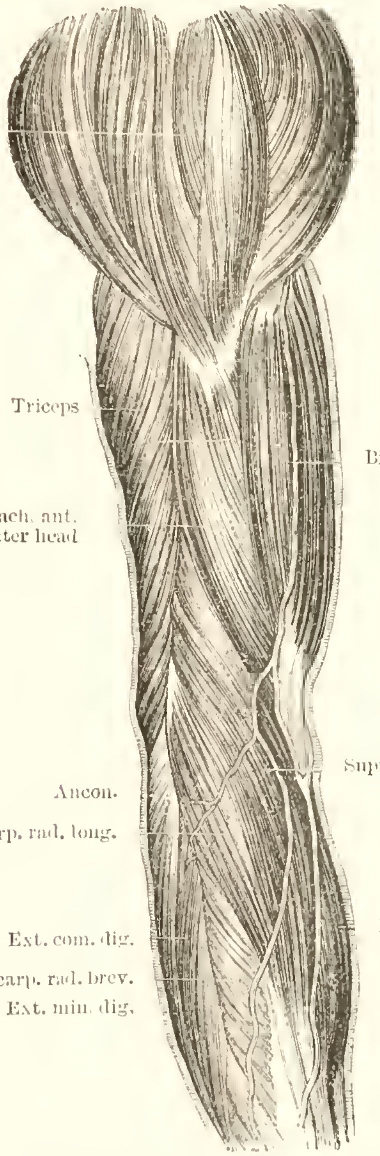


FIG. 88.—MUSCLES OF RIGHT ARM AND FOREARM. OUTER VIEW.

Some veins are also shown.

Relations.—In *front* it is superficial except at its ends. Its upper extremity is concealed by the deltoid and pectoralis major, and its tendon of insertion dips into the hollow in front of the elbow, and is in contact with the supinator brevis. *Behind* it is in relation with the shoulder joint and humerus, from which it is separated by the insertions of the subscapularis, teres major, latissimus dorsi, and origin of the brachialis anticus,

and by the musculo-cutaneous nerve. Its *inner border* is in relation with the coraco-brachialis, the median nerve, and the brachial vessels, and is also the guide to the brachial artery below the middle of the humerus, but above that point the coraco-brachialis is between them. Its *outer border* is in contact with the deltoid above and supinator longus below.

Actions.—It is a flexor of the forearm bending the elbow joint. It is also a supinator of the radius and a tensor of the deep fascia of the forearm, because of its aponeurotic expansion to that fascia. If the forearm be fixed it will flex the arm upon it, and if the arm be hanging and the radius fixed, the long head will help to remove the limb from the thorax, and when abduction is complete, the short head will aid in restoring the limb to its original position.

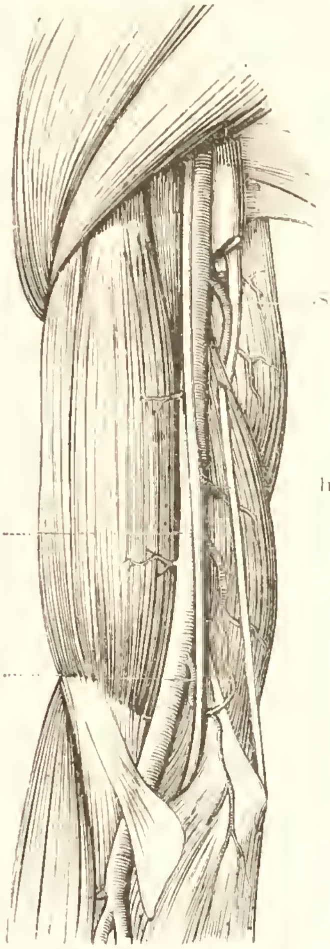
Nerve.—The external or musculo-cutaneous.

Varieties.—This is one of the most variable muscles in the human body. Its coracoid and glenoid portions may be separated a long way down or may even only meet at the tendon of insertion: but a more common peculiarity is perhaps the increase in the number of its heads of origin. According to Theile, a third head is found once in eight or nine subjects, arising at the upper and inner part of the brachialis anticus, being continuous with its fibres, or from the insertion of the coraco-brachialis, and being inserted into the under-surface of the bicipital fascia so as to form a tensor of that fascia, and also into the inner side of the biceps tendon. This additional head lies usually on the outer side of the brachial artery, but sometimes behind it and occasionally in front of it. In some instances a third head consists of two slips, one passing in front and the other behind the artery, concealing it in the lower half of the arm. A muscular fasciculus passing from the biceps over the brachial artery to the inner intermuscular septum has also been seen. Gruber has described a third head passing from the outer side of the humerus and sometimes from the bicipital groove or great tuberosity to the radius (*brachio-radialis*). Sometimes the long head does not reach the glenoid process of the scapula, but stops in the bicipital groove. I have seen this in old subjects; and in one instance I felt sure it had been the result of disease, as there were indications of chronic arthritis in the shoulder joint. On one side of a subject in the London Hospital dissecting room there was a fourth diminutive head.

The **Brachial Artery** is the continuation of the axillary, and commences at the lower margin of the tendon of the teres major, and passing down the inner and anterior aspect of the arm, ends opposite the neck of the radius in the radial and ulnar arteries. It gradually inclines from the inner to the fore part of the arm, lying in the groove along the inner border of the coraco-brachialis and biceps muscles, and its direction may be indicated by a line drawn from near the outer side of the axilla to midway between the humeral condyles. In the upper part of its course it is superficial and lies internal to the humerus, but below, at the elbow, it lies in front of that bone and is more deeply placed.

Relations.—In *front* are the skin, superficial and deep fasciae, and at the elbow the bicipital fascia, which separates it from the median basilic vein. The basilic vein lies along the course of the artery on its inner side, separated from it by the deep fascia in the lower half, and the median nerve crosses usually in front of, but sometimes behind it at its middle.

Behind, the long and inner heads of the triceps separate it above from the inner side of the humerus, the superior profunda artery and musculo-spiral nerve intervening; and below it is separated from the front of the bone by the insertion of the coraco-brachialis and by the brachialis anticus. *Inside* it is in relation with the internal cutaneous and ulnar nerves, in its upper half, and in its lower half with the median. *Outside* is the



The basilic vein is cut. The median nerve is over the artery, and the ulnar to its inner side, and part of the musculo-spiral near the vein. The bicipital fascia is over the vessel, just above its bifurcation into radial and ulnar. The biceps is external to the artery, and the coraco-brachialis between it and the artery above, and just above both is the pectoralis major, above which is the deltoid. Internal to the vein is the tendon of the latissimus dorsi, below which is that of the teres major, and behind the superior profunda and musculo-spiral nerve is the long head of the triceps. At the elbow-bend the supinator longus is outside the artery, the bicipital fascia above, and the pronator teres inside it.

FIG. 89.—RIGHT BRACHIAL ARTERY AND BRANCHES.

commencement of the median nerve, and the coraco-brachialis and biceps muscles, which slightly overlap it. Two venæ comites accompany it and are closely applied to the artery, being connected here and there by short transverse branches.

RELATIONS OF THE BRACHIAL ARTERY.

In front.—Skin, fasciæ, cutaneous vessels and nerves, median nerve, bicipital fascia, and median basilic vein.

Outside.—Median nerve, coraco-brachialis and biceps, and humerus and vena comes.

Brachial Artery

Inside. — Internal cutaneous ulnar and median nerves, and vena comes.

Behind.—Inner head of triceps, musculo-spiral nerve, superior profunda artery, coraco-brachialis, and brachialis anticus and humerus.

Variations.—This vessel is subject to many peculiarities in its division, course, distribution, and relations, which possess special surgical interest, not only from the comparative frequency of its peculiarities, but because it has not unfrequently to be tied or compressed.

Course.—Sometimes the brachial artery and median nerve pass towards the inner condyle to regain its usual position at the bend of the elbow, either through a bony prominence or ring, which was mentioned in giving the surface markings, or under a fibrous arch, from which, in this case, the pronator teres arises. Sometimes this anomaly occurs without the development of any bony prominence. This abnormal condition in man resembles the normal position of the artery in some of the carnivora. A very rare condition consists in the division of the brachial into two vessels near its origin, the artery being single above and below. Another rare occurrence is the origin of the radial ulnar and interosseous together, from the end of the brachial at the ordinary situation below the elbow.

Division.—This may be above or below the usual point, the normal condition prevailing; i.e. in about three-fourths of the cases the vessel bifurcates in its normal position. When the artery divides *above* its usual point (it may do so at any point from the axilla to behind the elbow), the radial in three cases out of four is the one prematurely given off; but sometimes it is the ulnar, or a branch corresponding to the ulnar in its distribution below the middle of the forearm is given off from the trunk, which subsequently divides into the usual radial and interosseous arteries of the forearm, the latter being ordinarily a branch of the ulnar. There is no correspondence between the arteries of the two arms of the same subject, with reference to this irregular division. In sixty-one bodies it was present on one side only, in forty-three on both sides, in different positions in thirteen, and on both sides in the same position in five. The point of division is most frequently in the upper, less so in the lower, and less in the middle third of the arm, where it is usually tied. In any of these instances two large vessels would be found in the arm instead of one. Two vessels instead of one are present in some part of the arm in about one out of five subjects.

The position of these two vessels possesses much surgical interest. Commonly they are close together and occupy the usual position of the brachial, but the radial artery when given off in this manner frequently arises from the *inner* side of the brachial, and runs *posteriorly* with the larger vessel (the brachial or ulnar interosseous), and crosses over it at the bend of the elbow under the deep fascia, but very often it pierces the fascia near the elbow and runs subcutaneously.

If the ulnar be the branch given off high up from the brachial, it frequently leaves the ordinary position of the brachial at the lower part of the arm near the inner condyle. It is generally superficial to the flexors, but under the fascia, and sometimes between the skin and fascia, and very rarely beneath the muscles. In some instances the two vessels representing the brachial are joined at the bend of the elbow by a transverse branch, which comes from the larger (or larger interosseous) to the radial or radial recurrent, and more rarely the two anomalous vessels are really reunited.

The *vasa aberrantia* or aberrant arteries are long slender vessels which

come from the brachial or axillary and join one of the arteries of the forearm. A branch from beneath these vessels generally joins the radial.

The interosseous artery sometimes arises from the upper part of the brachial or axillary, and usually passes down the arm behind the main trunk, and at the elbow passes deeply between the muscles to regain its usual position in the forearm.

Peculiarities in Muscular Relations.—In the upper third of the arm the brachial vessels and median nerve may be covered for three inches by a thick muscular layer from the coraco-brachialis. In the lower half of the arm it may be concealed by a thin broad extra head of the biceps muscle, and a narrow muscular slip from the biceps may also cover the vessel for an inch and a half. A musculo-tendinous slip coming from the external bicipital ridge may cross the artery very obliquely, and lie in front of it for three inches, and be then inserted into the fascia over the pronator teres. A tendinous slip from the deep part of the pectoralis major tendon may obliquely cross the vessel and join the inner intermuscular septum. Not uncommonly the brachialis anticus projects on the outer side of and may overlap the vessel, or it may give off an aponeurosis which passes inwards over the artery and binds the latter down to itself. Sometimes a fleshy fasciculus from the same vessel covers the artery to the extent of two or three inches. When the pronator teres arises high up the fibrous expansion from it passes to the brachialis anticus on the outer side of the vessel, concealing it for about half an inch above the condyles, and forming an arch under which the brachial artery and median nerve pass.

Surgical Anatomy.—To compress this vessel the pressure must be directed from within outwards at the upper part of its course, and in the lower half from before backwards. The insertion of the coraco-brachialis is the seat of election for compression. In wounds of the vessel itself or of those of the forearm or palmar arches, or in aneurisms of the main trunk or its branches, and in some rarer instances, the vessel will have to be tied. If the student have made himself familiar with the relations of the vessels as described he will ordinarily have no difficulty after feeling its pulsation in cutting down upon it, and if he be aware of the most common variations as regards position, division and relations, he will be prepared for abnormal occurrences.

Collateral Circulation.—If the brachial be tied in the upper third of the arm, the blood is brought into the limb beyond the seat of ligature by descending branches given off from the trunk or its branches above the seat of ligation, joining branches which are given off from the brachial or its branches below the point tied. These latter are ascending or *recurrent*. If the ligature lie at the point stated, branches from the circumflex and subscapular arteries join ascending branches from the superior profunda, but if the brachial be tied below the origin of both profundæ, the circulation is continued by the branches of these vessels joining the recurrent branches from the radial, ulnar, and interosseous.

Branches.—These are given off from the outer and inner side of the brachial; the former are usually muscular and supply the biceps, coraco-brachialis and brachialis anticus. The inner branches are the superior and inferior profundæ, the nutrient and anastomotica magna.

The **Superior Profunda** is larger than the others, and is given off from the inner and back part of the brachial near the lower border of the

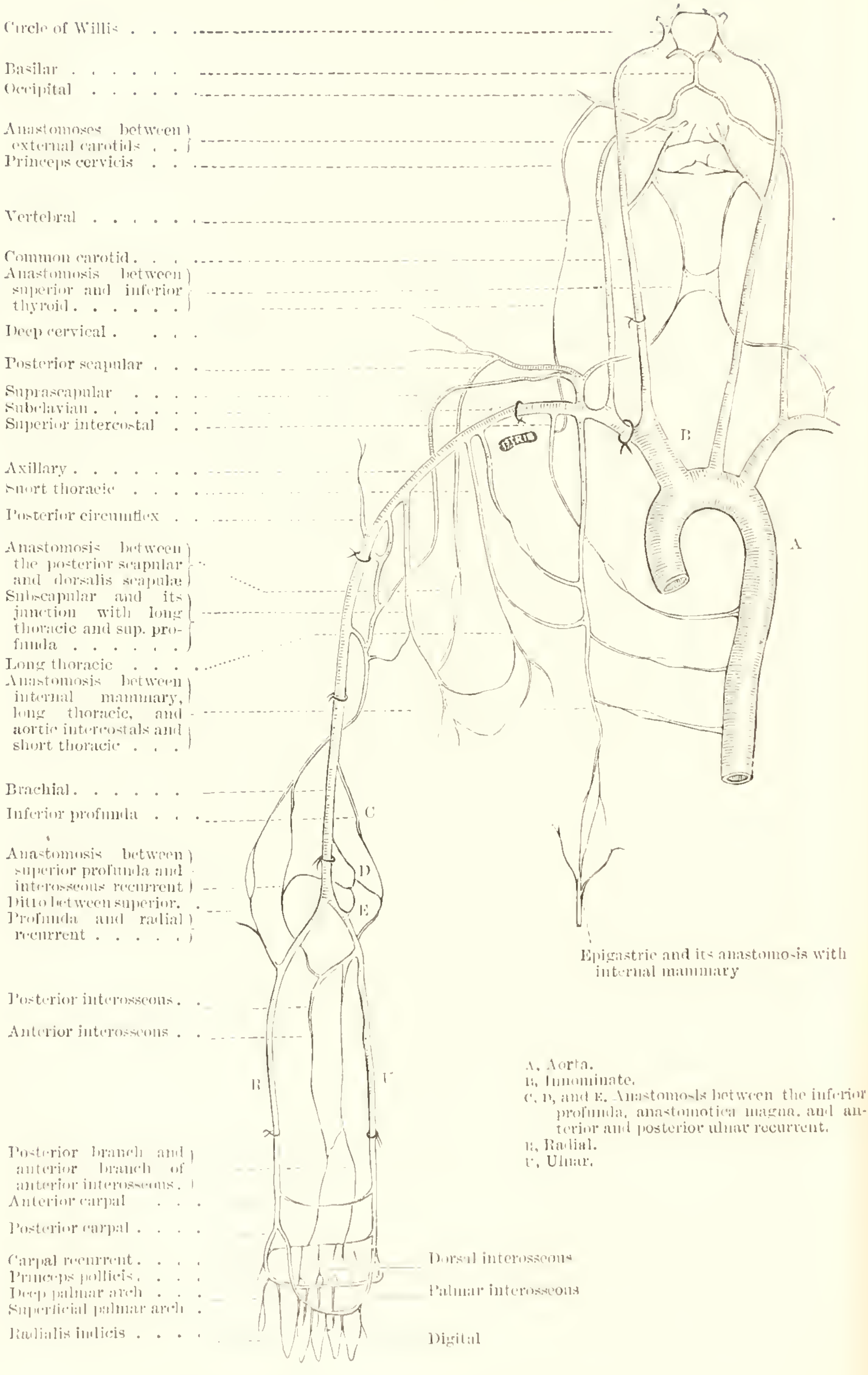


FIG. 90. DIAGRAM OF THE COLLATERAL CIRCULATION OF THE ARM

Altered from Smith and Walsham.

teres major. It passes back and out with the musculo-spiral nerve in the musculo-spiral groove of the humerus between the outer and inner heads of the triceps and the bone to the outer side of the elbow, and pierces the external intermuscular septum with the musculo-spiral nerve. It will be subsequently traced in the dissection of the back of the arm between the brachialis anticus and supinator longus to anastomose with the recurrent radial.

Varieties.—In describing the anomalies of the axillary trunk and its branches, it was stated that the superior profunda might give origin to the

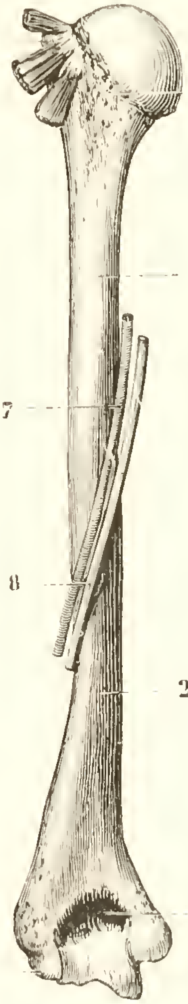


FIG. 91.—POSTERIOR ASPECT OF LEFT HUMERUS, TO SHOW HOW THE ARTERY AND NERVE WIND ROUND BETWEEN THE OUTER AND INNER HEADS OF TRICEPS.

posterior circumflex, and that its own origin might be transferred to a branch from the axillary.

The *Nutrient Artery* arises about the middle of the arm, near the inferior profunda, and passing down enters a large nutrient foramen near the insertion of the coraco-brachialis, and passes to supply the osseous and medullary substance of the humerus, its direction being towards the elbow.

The **Inferior Profunda** arises opposite the insertion of the coraco-brachi-

alis, accompanies the ulnar nerve, and piercing the internal intermuscular septum descends on the inner head of the triceps to the space between the olecranon and the inner condyle, and ends by anastomosing with the anastomotica magna and posterior ulnar recurrent, and by a branch over the front of the inner condyle joins the anterior ulnar recurrent. It supplies the inner part of the triceps, and may arise in common with the superior profunda.

Varieties.—This vessel is occasionally absent, and for this reason some anatomists do not recognise it as a regular branch of the brachial.

The **Anastomotica Magna** is given off about an inch and a half to two inches above the elbow, and crosses transversely inwards over the brachialis anticus to pierce the inner intermuscular septum, and passes back between the humerus and the triceps to the space between the olecranon and the

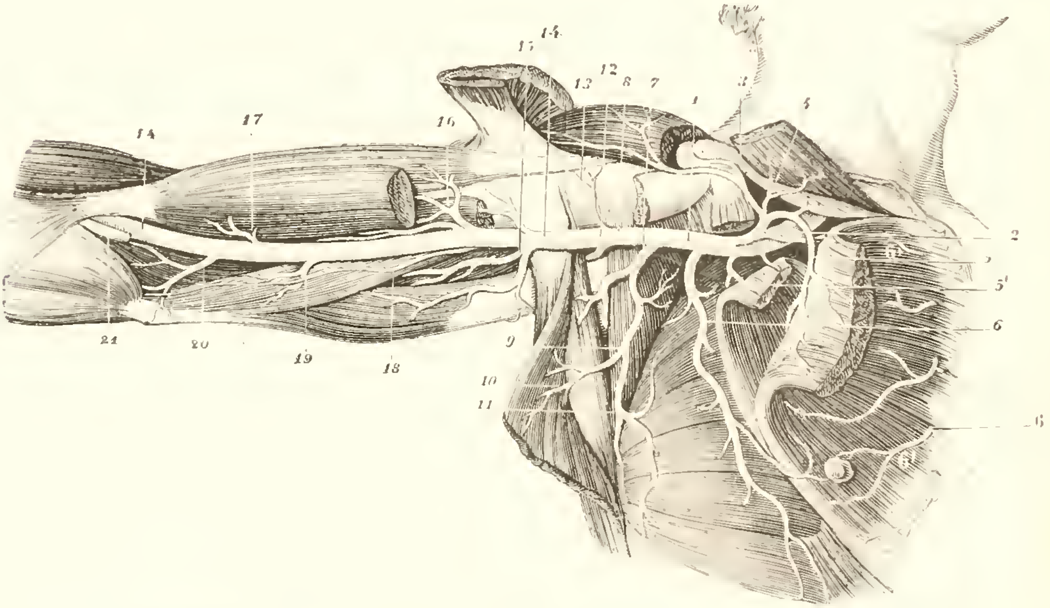


FIG. 92.—BRANCHES OF THE RIGHT AXILLARY AND BRACHIAL ARTERIES.

1. Axillary.
2. Acromio-thoracic.
3. Acromial branch of 2.
4. A muscular branch of 2.
5. Thoracic branch of 2.
5'. Alar or posterior thoracic.
6. Long thoracic.
6'. Anterior perforating of internal mammary.
7. Subscapular.
8. Dorsalis scapulæ.
9. Continuation of subscapulars.
10 and 11. Muscularsof subscapular.
12. Posterior circumflex.
13. Anterior circumflex.
14. Brachial.
15. Superior profunda.
16, 17, 18. Muscular.
19. Inferior profunda.
20. Anastomotica magna.
21. Median nerve cut.

The pectorals, biceps, coraco-brachialis, and latissimus dorsi are cut and reflected.

inner condyle. It forms an arch above the olecranon fossa with the *posterior articular* branch of the superior profunda, and gives off an offset between the olecranon and inner condyle, which joins the inferior profunda and posterior ulnar recurrent arteries, and some twigs pass in front of the inner condyle to inosculate with the anterior ulnar recurrent, while others ascend to join the inferior profunda. It gives branches to the triceps and pronator teres muscle.

Varieties.—This artery is sometimes very small, and in such a case the inferior profunda takes its place behind the humerus.

The *Muscular* branches are three or four large vessels which supply the coraco-brachialis, biceps and brachialis anticus.

The *Brachial Veins* are the venæ comites of the brachial artery, and are

placed one on each side of it, receiving branches corresponding with those given off from the artery, and are connected by transverse branches of communication. Near the lower border of the subscapularis they unite into one vessel with the basilic to form the axillary vein.

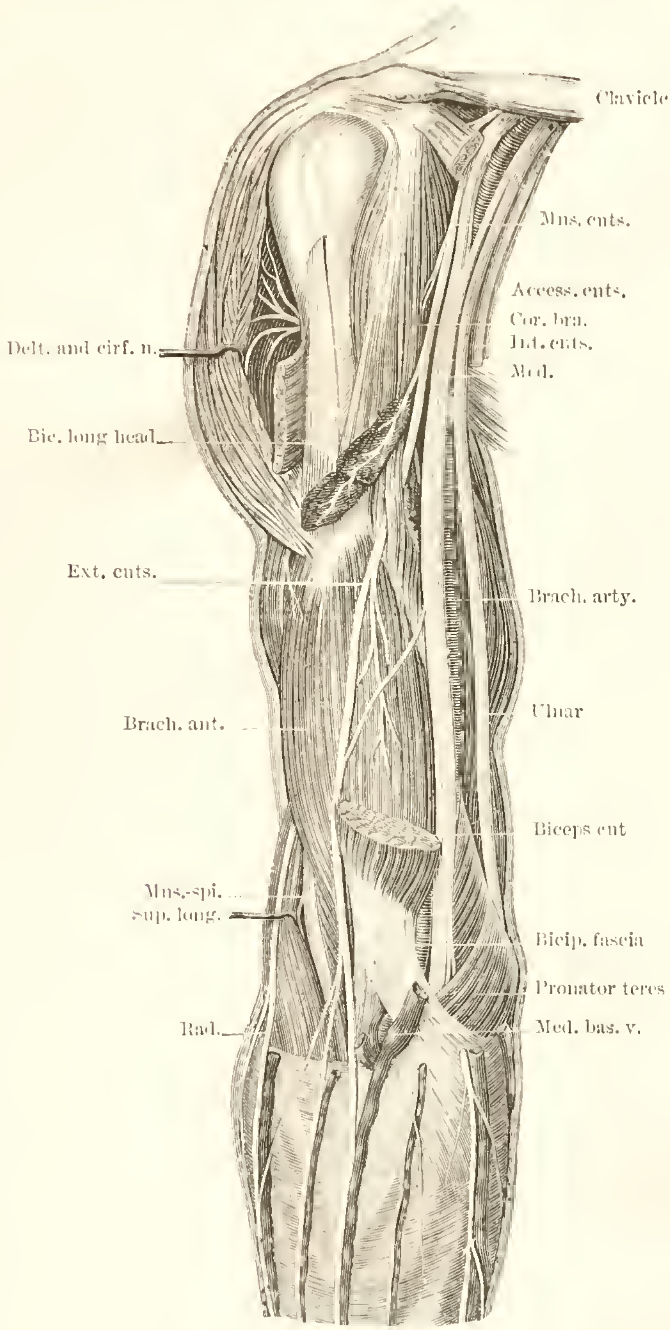


FIG. 93.—DEEP NERVES OF RIGHT ARM.

The two heads of the median, including the last part of axillary artery, are shown. The tendons of the pectoralis major and minor are cut, and the long head of the biceps is in its groove. The deltoid, triceps, and short head of biceps are cut and reflected.

Nerves of the Front of the Arm.—These come from the terminal cords of the brachial plexus. The *median* and *ulnar* pass into the forearm usually without giving any branches.

The **Median Nerve** was named from its course. It runs along the middle of the arm and forearm to the hand, and lies between the ulnar on the inner, and the musculo-spiral and radial on the outer side. It arises by two roots, from the outer and inner cords of the plexus—these enclose the third part of the axillary artery, join in front or on the outer side of the vessel—and, passing down the arm, is at first on the outer and then usually in front of the brachial artery in the middle of the arm; but sometimes it lies behind it, and at the bend of the elbow is on its inner side, where it is placed beneath the bicipital fascia, resting on the brachial anticus. It gives no branches in the arm, and its relations are similar to those of the artery.

Varieties.—There may be a doubling of one or both heads, and the outer head may pass behind instead of in front of the brachial artery. It may frequently pass behind the brachial, and may enter the forearm by passing *over* the pronator teres instead of between its heads. Sometimes there is a fasciculus in the arm, connecting it with the musculo-cutaneous. In very rare instances it may accompany the brachial artery beneath the supra-condylar process, as mentioned in describing the anomalies of this vessel.

The **Ulnar Nerve** runs along the inner side of the limb to the muscles and skin of the forearm and hand. It is smaller than the median, being placed behind it, and arises from the inner cord of the brachial plexus in common with the internal cutaneous and inner head of the median. At first it is close to the inner side of the axillary and brachial arteries, and at the middle of the arm crosses obliquely over the inner head of the triceps, through the inner intermuscular septum and fibres of the triceps, to the groove between the olecranon and internal condyle, accompanied by the inferior profunda artery. It enters the forearm between the two heads of the flexor carpi ulnaris. There are no branches of this nerve in the arm, but between the olecranon and inner condyle it gives some small articular filaments to the elbow.

Varieties.—Sometimes the ulnar gives muscular twigs to the inner head of the triceps in the upper part of the arm, and if the *epitrochleo-anconeus* muscle be present, it receives a branch from the ulna. In three instances Gruber has observed the nerve passing in front instead of behind the inner condyle.

The *Internal Cutaneous* comes from the inner cord of the plexus, and is superficial to the brachial artery as far as the middle of the arm, where it divides into two branches that pierce the deep fascia, and near the axilla it gives an offset to the skin and the inner side of the arm. It is continued on to the inner side of the forearm.

The *Lesser Internal Cutaneous*, or *nerve of Wrisberg*, arises from the inner cord, generally with the preceding. It is at first behind the axillary vein, and then passes beneath (but sometimes through the vein) and joins the intercosto-humeral. Afterwards it runs along the inner side of the arm as far as its middle, where it pierces the deep fascia, and supplies the skin of the arm as far as the inner side of the elbow.

The **Musculo- or External Cutaneous** (or *perforans Casserii*) supplies the muscles and skin of the front of the arm, and ends in the forearm. It comes from the outer cord of the brachial plexus near the lower border of the pectoralis minor, then pierces the coraco-brachialis, which it supplies,

and passes obliquely out between the biceps and brachialis anticus to just above the elbow, where it pierces the deep fascia, and divides into anterior and posterior cutaneous branches to the forearm. It supplies the biceps, coraco-brachialis, and part of the brachialis anticus muscles, and sends filaments to the humerus and elbow joint.

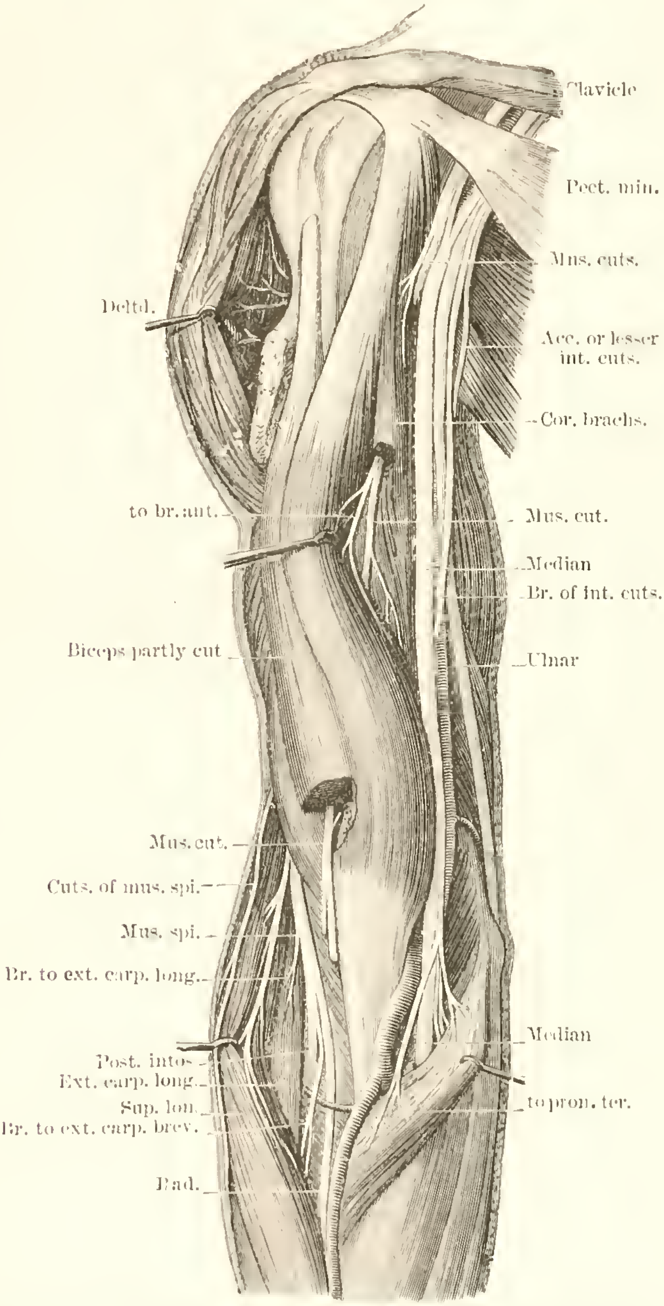


FIG. 94.—DEEP NERVES OF RIGHT ARM. ANTERIOR VIEW.

The brachial and radial arteries are partly seen.

Varieties.—The chief part of this nerve, instead of piercing the muscle, may remain adherent to the outer root or trunk of the median, and then the muscle gets a separate branch from the brachial plexus.

Not infrequently it joins the median or may be a branch of it. Sometimes it does not pierce the coraco-brachialis.

Dissection.—Cut through the biceps tendon near the elbow, and reflect the muscle upwards. Clean the surface of the brachialis anticus, and define its lateral attachments.

The **Brachialis Anticus** is a broad muscle compressed from before back, and is narrower at its extremities than in the middle. It arises from the anterior and lower half of the outer and inner surfaces of the humeral shaft, and embraces by two processes the insertion of the deltoid. Its origin extends to within an inch of the lower articular surface of the humerus,

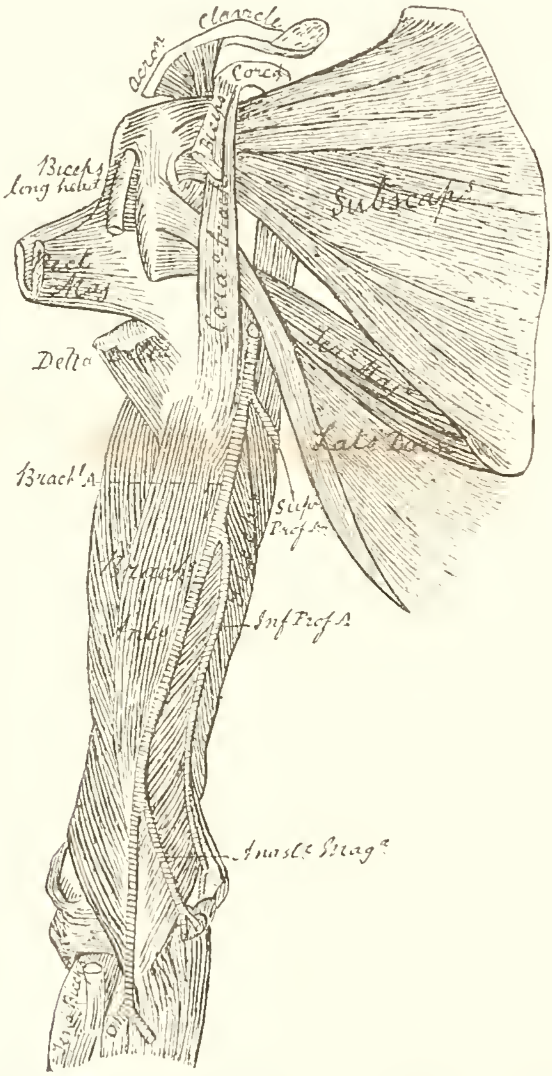


FIG. 95.—MUSCLES OF FRONT OF ARM AND SCAPULA.

and it also arises from both intermuscular septa, but more extensively from the inner. Its fibres converge to a thick tendon, which is inserted into a rough impression on the anterior surface of the coronoid process of the ulna, in an interval between two fleshy origins of the flexor profundus digitarum.

Relations.—In *front* with the biceps, the brachial vessels, musculo-cutaneous, and median nerves, and above the deep fascia with the cephalic and basilic veins, and the veins and nerves in front of the bend of the

elbow; *behind*, with the humerus and anterior ligament of the elbow. Its *inner border* is in relation with the triceps, ulnar nerve, and pronator teres, from which it is separated by the intermuscular septum. Its *outer border* is separated below from the external intermuscular septum by the supinator longus and extensor carpi radius longior, and is in relation with the musculo-spiral nerve and radial recurrent artery.

Actions.—It is a flexor of the forearm, as it draws the ulna towards the humerus. If the forearm be fixed, it will flex the arm upon the forearm. It protects the front of the elbow joint.

Nerves.—The musculo-cutaneous, and often a twig from the musculo-spiral.

Varieties.—It is subject to many changes, the most common being its breaking up into two or more parts, or it may blend with the supinator longus, biceps, or pronator teres. It may be inserted into the upper part of the *radius*, or partly into the *bicipital* or *semilunar fascia.*

POSTERIOR HUMERAL REGION.

Directions.—Place the limb on the table on its anterior aspect, and semiflex the elbow by placing a block beneath it. Render the muscular

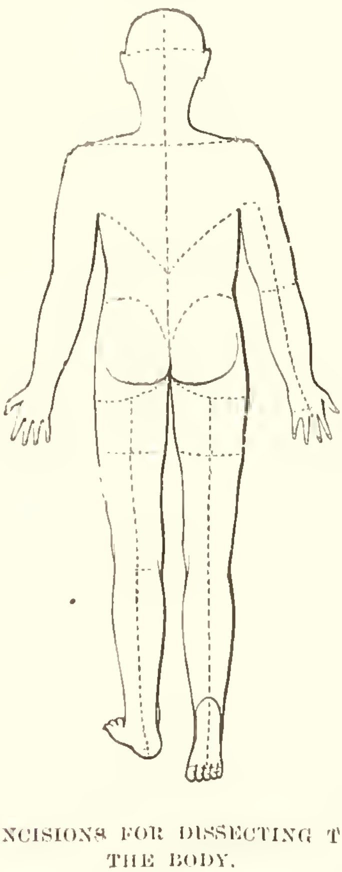
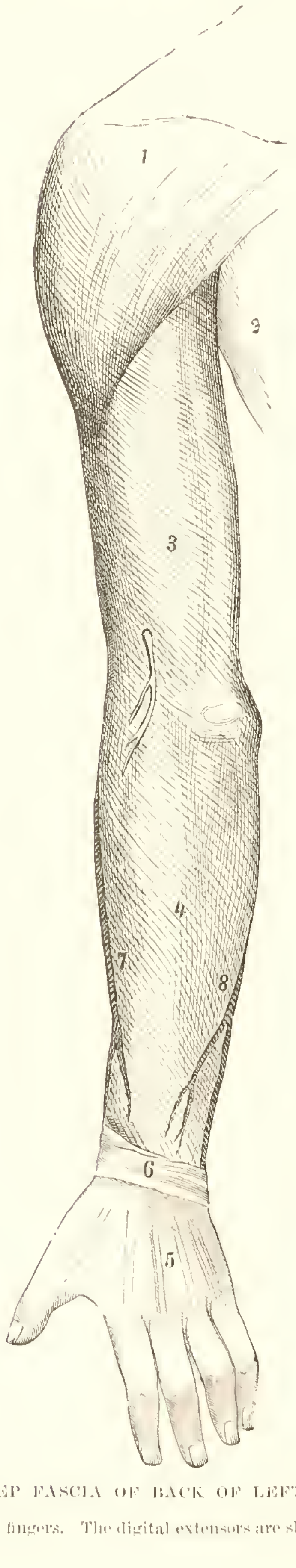


FIG. 96.—DIAGRAM OF INCISIONS FOR DISSECTING THE POSTERIOR PARTS OF THE BODY.

fibres tense by placing the scapula at a right angle to the humerus, and fastening it there with hooks.

Dissection.—The skin has already been nearly completely reflected from this part. The student must entirely separate it and make a vertical



1. Deltoid fascia.
2. Dorsal thoracic fascia.
3. Brachial fascia.
4. Antibrachial fascia.
5. Manual dorsal „
6. Post. ann. lig.
7. Cephalic v.
8. Basilic v.

Fig. 97.—Deep fascia of back of left upper limb.

The skin is left on the ends of the fingers. The digital extensors are shown through the thin dorsal fascia.

incision through the deep fascia to a little below the elbow, and must then reflect it, also a little loose connective tissue beneath it, and find the nerves, as in the annexed figure of the cutaneous nerves.

Cutaneous Nerves.—These are the posterior branch of musculo-spiral at the upper and inner side near the axillary fold, just below which is the intercosto-humeral, and lower down is the nerve of Wrisberg. Close below this is the internal cutaneous branch of the musculo-spiral, and a little lower down is the upper cutaneous branch of the internal cutaneous. Just below the elbow on the inner side is the lower posterior branch of the internal cutaneous. Thus there are five nerves on the inner side. Follow-

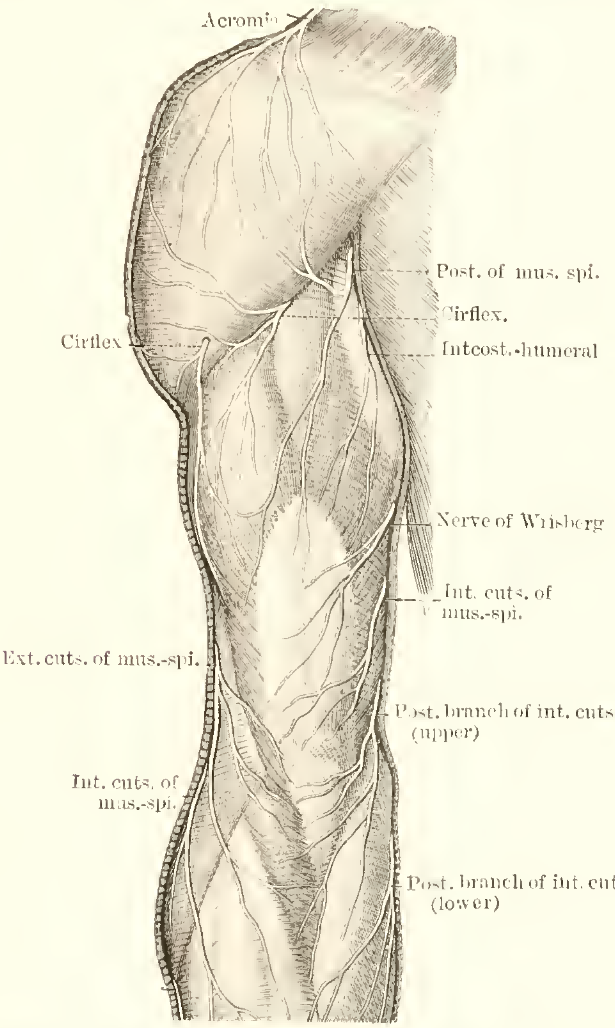


FIG. 98.—CUTANEOUS NERVES OF BACK OF LEFT SHOULDER, ARM AND ELBOW.

The deep fascia is beneath them.

ing the lower border of the deltoid are two branches of the circumflex, of which the outer sends a branch down the outer side of the arm. The external cutaneous of the musculo-spiral is on the outer side just above the elbow, and below this is the internal cutaneous branch of the same nerve. Anastomotic twigs connect the various nerves.

There is but one muscle, the triceps, on the back of the arm, between the inner and outer heads of which the musculo-spiral nerve and superior profunda vessels, passing down and out, must be traced.

The **Triceps** muscle extends the whole length of the posterior surface of the humerus, and is a large muscle divided into three parts of origin or heads, hence its name. These three heads are: 1, the middle, scapular,

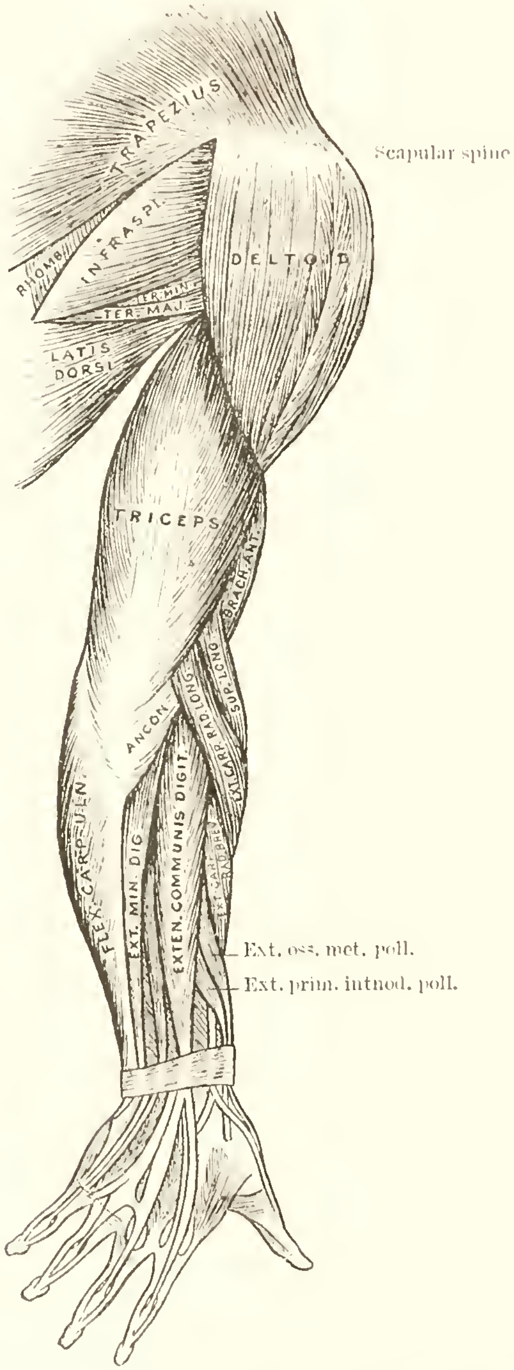


FIG. 99.—SUPERFICIAL MUSCLES OF THE BACK OF RIGHT UPPER LIMB.

At the bases of the metacarpals of the index and second fingers are the insertions of the extensors carpi longior and brevior.

or long head; 2, the external or long humeral; and 3, the internal or short humeral. These are attached to the humerus, and also to the scapula.

The *middle head* is the longest, and arises by a flattened tendon about

an inch wide from a roughish triangular surface just below the glenoid cavity of the scapula, being blended with the capsular and glenoid ligaments. Its muscular fibres pass vertically down to between the outer and inner heads, and join the common tendon of insertion with them.

The *inner head* is wide and muscular, and arises from the posterior aspect of the humeral shaft *below* the musculo-spiral groove. Its origin is narrow and pointed, and is attached just below the insertion of the teres major, and extends, reaching laterally to the inner intermuscular septum, to within an inch of the lower articular surface of the humerus. It is also attached to the internal border of the humerus. The fibres of this head pass, some to the common tendon of insertion, and others down to the olecranon.

The *external head* is narrow, and arises from the posterior surface of the humerus *above* the musculo-spiral groove, and between the latter and the insertion of the teres minor. It is also attached to the outer border of the humerus, and to the external intermuscular septum. The fibres converge towards its tendon of insertion.

The *common tendon of insertion* of the triceps begins about the middle of the posterior part of the muscle, and consists of two tendinous laminæ, one being subcutaneous and covering the posterior aspect of the muscle for its lower half, the other being more deeply placed in the substance of the muscle, and, after receiving its muscular fibres, both tendons join above the elbow to be inserted into the back and tip of the olecranon process, giving an expansion to the deep fascia of the forearm. A small bursa, sometimes *multilocular*, is commonly situated between the bone and the tendon, and there is a subcutaneous one between the skin and bone.

Relations.—Posteriorly, above is the deltoid, and it is subcutaneous in its remaining part; *anteriorly*, with the humerus superior profunda vessels, musculo-spiral nerve and posterior ligament of the elbow. Its *long head* is in relation in *front* with the subscapularis, teres major, and latissimus dorsi, and *behind* with the deltoid and teres minor. The dissector will recollect that the long head passes between the teres major and minor, dividing the triangular interval between these two muscles and the humerus into two smaller spaces, one of which is near the humerus, and is quadrangular, and the other is near the scapula, and is triangular. The *quadrangular* space is bound *above* by the lower border of the teres minor, *below* by the upper borders of the latissimus dorsi and teres major, *outside* by the humerus, and *inside* by the outer border of the scapular head of the triceps. It transmits the posterior circumflex vessels and circumflex nerve and its branch to the teres minor. The *triangular* space transmits the dorsalis scapulæ vessels, and is bounded *above* by the lower border of the teres minor, *below* by the upper border of the teres major, *outside* by the inner border of the long head of the triceps. The lower portion of the *outer* head of the triceps is usually continuous with the anconeus muscle.

Actions.—The triceps is the main extensor of the forearm, and directly antagonises the biceps and brachialis anticus, which are its flexors. If the arm be extended, the long head may aid the latissimus dorsi and teres major to draw the humerus backwards. The long head can depress the raised humerus, adduct it, and tend to prevent dislocation downwards.

Nerve.—The musculo-spiral supplies the triceps.

Varieties.—A fourth head from the inner surface of the humerus,

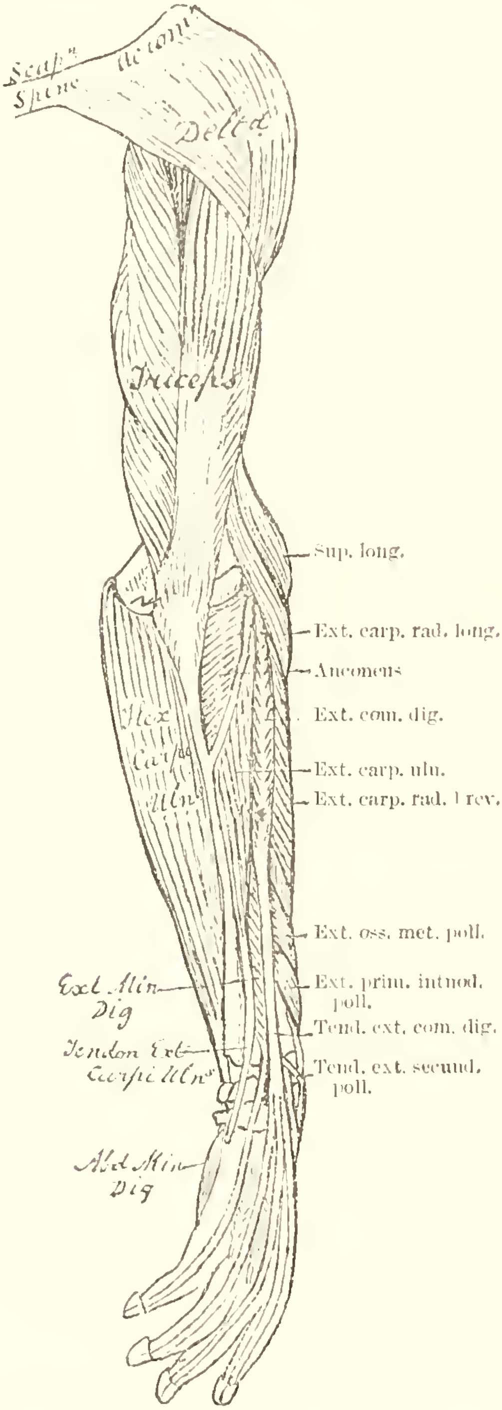


FIG. 100.—POSTERIOR MUSCLES OF ARM, AND INTERNAL VIEW OF FOREARM MUSCLES.

Two dorsal interossei are indicated.

arising near to or above the inner head, may be present, or a communicating slip between the triceps and latissimus dorsi, corresponding with

the *accessory triceps* or *dorsi epitrochlearis.* This muscle exists in several of the lower mammalia, and is common among the quadrumana. A small muscle, usually a part of the triceps, arising from behind the inner condyle, and being inserted into the inner side of the olecranon, has been observed by W. Gruber and Wood, and has been named the *epitrochleo-anconeus.*

Dissection.—The middle head of the triceps should be divided about its middle, and the fatty tissue removed from the superior profunda vessels and the musculo-spiral nerve; and these should be traced between the outer and inner heads of the muscle, and through the external inter-muscular septum to their situation between the supinator longus and brachialis anticus. The outer and inner intermuscular septa should be

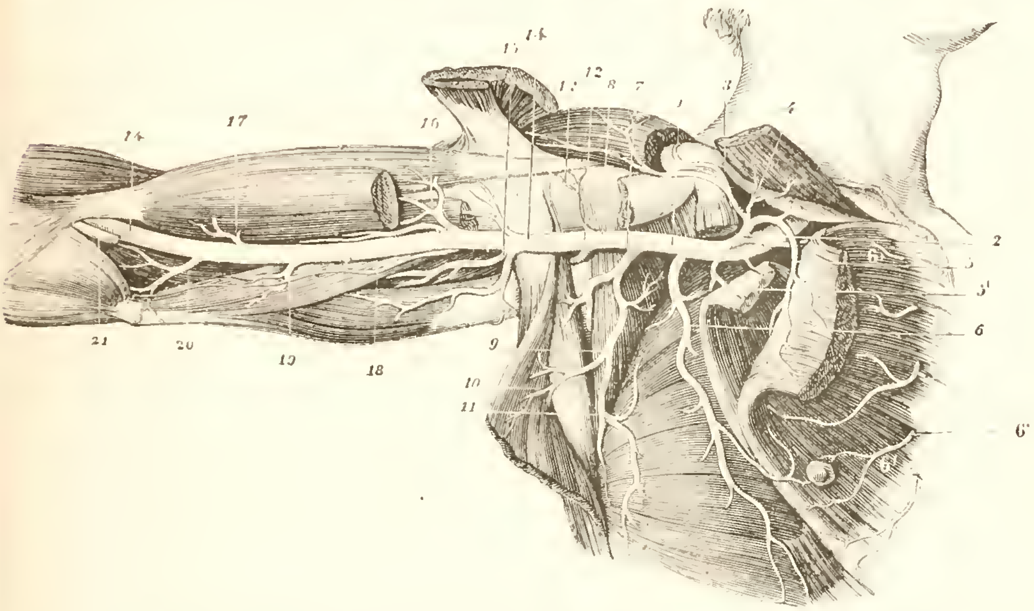


FIG. 101. BRANCHES OF THE RIGHT AXILLARY AND BRACHIAL ARTERIES.

1. Axillary.
2. Acromio-thoracic.
3. Acromial branch of 2.
4. A muscular branch of 2.
5. Thoracic branch of 2.
5'. Alar or posterior thoracic.
6. Long thoracic.
6'. Anterior perforating of internal mammary.
7. Subscapular.
8. Dorsalis scapulæ.
9. Continuation of subscapulars.
10 and 11. Musculars of subscapular.
12. Posterior circumflex.
13. Anterior circumflex.
14. Brachial.
15. Superior profunda.
16, 17, 18. Muscular.
19. Inferior profunda.
20. Anastomotica magna.
21. Median nerve cut.

The pectorals, biceps, coraco-brachialis, and latissimus dorsi are cut and reflected.

defined, and piercing the inner, the ulnar nerve and inferior profunda artery must be made out. Then the triceps should be separated along the line of junction of the outer and middle heads, so as to trace out the branches of the superior profunda artery and musculo-spiral nerve which descend to the anconeus muscle and olecranon.

The intermuscular septa have been described with the deep fascia of the arm. They separate the muscles on the front from those on the back of the arm, and their attachments to the external and internal condyloid humeral ridges should be made out.

The **Superior Profunda** branch of the brachial artery supplies the triceps, and accompanying the musculo-spiral nerve winds in the musculo-spiral groove to the back and outer side of the humerus between the inner and outer heads of the triceps. It gives branches to the deltoid, coraco-brachialis, and triceps muscles, and while in the groove between the

triceps and the humerus gives off the *posterior articular* branch, which descends vertically between the muscle and the bone to the back part of the elbow joint, where it joins the *posterior interosseous recurrent* branch, and on the inner side of the arm anastomoses with the posterior ulnar recurrent and anastomotica magna or inferior profunda. Very often a small offset accompanies the musculo-spiral nerve, and joins the recurrent radial artery, and another ends in the anconeus below the outer condyle. Two or three cutaneous twigs from the outer side of the vessel accompany the cutaneous nerves.

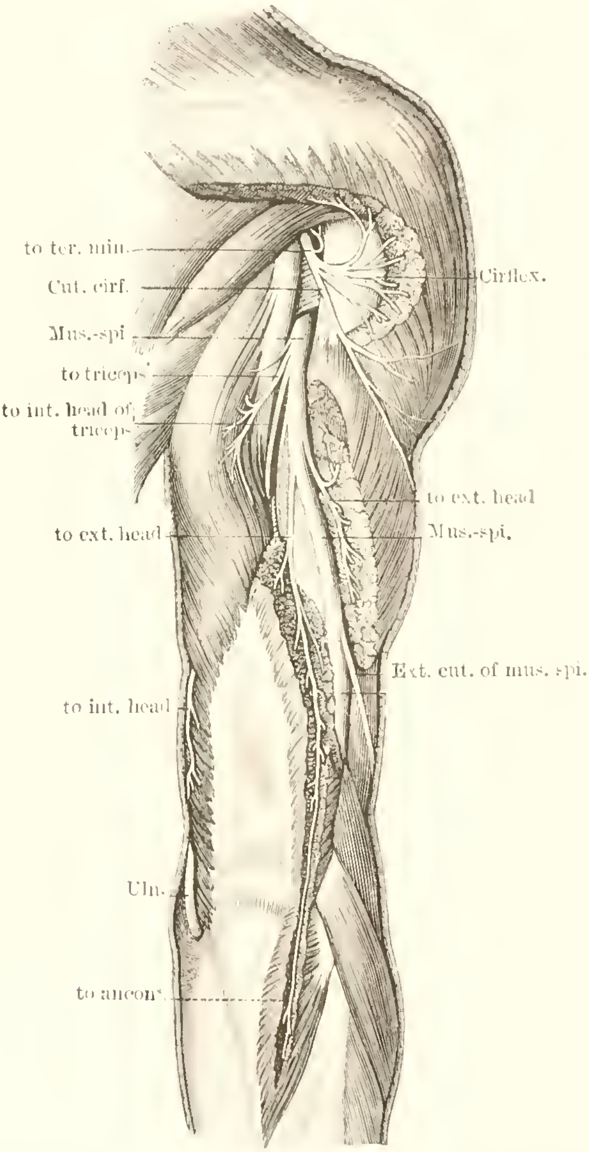


FIG. 102. DISSECTION OF BACK OF RIGHT ARM, TO SHOW MUSCULO-SPIRAL NERVE AND ITS BRANCHES.

The **Musculo-Spiral Nerve** is the largest of the branches from the brachial plexus, and supplies the triceps and the skin of the back part of the arm and forearm, and by its radial branch the back of the hand also. It comes, as before said, from the posterior cord, of which it is the only continuation prolonged into the arm, by a trunk common to it and the circumflex, and

is at first placed behind the last part of the axillary and the upper part of the brachial arteries, being in front of the tendons of the latissimus dorsi and teres major. It winds from the inner to the outer side of the humerus with the superior profunda artery beneath the fibres of the triceps, and between its outer and inner heads and at the outer side of the arm and at its lower third it descends between the supinator longus and brachialis anticus to the front of the outer condyle, where it divides into a large branch, the *posterior interosseous*, which is mainly muscular, and a small branch, the *radial*, which is entirely cutaneous in its distribution.

The branches of this nerve are three muscular, three cutaneous, and the two terminal, viz., the radial and posterior interosseous.

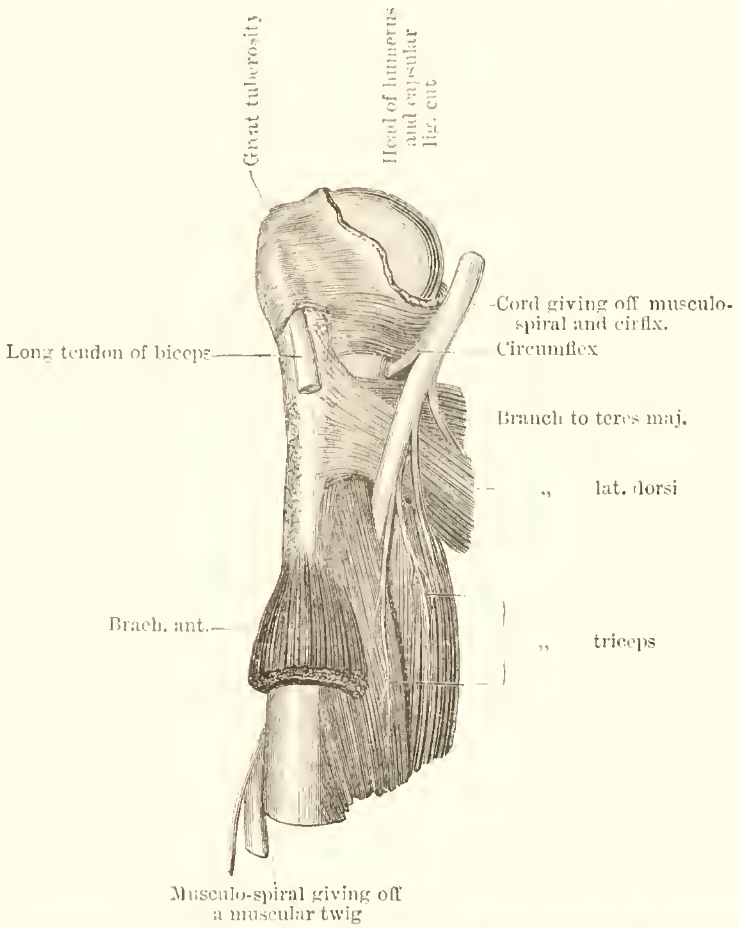


FIG. 103.—THE COURSE AND UPPER BRANCHES OF THE RIGHT MUSCULO-SPIRAL NERVE.

The *Muscular* branches are external, posterior, and internal, and leave the nerve at the inner, outer, and back part of the arm. The *inner* is a slender offset, arising usually in common with the inner cutaneous branch of the nerve, and is close to the ulnar, and supplies the inner and middle heads of the triceps, entering them at the lower third of the arm. The *posterior* branch is large, and is given off in the groove between the triceps and humerus. It supplies the outer head of the triceps, and can be traced onwards to the anconeus, accompanying the posterior articular branch from the superior profunda. The *external* branch supplies, usually, the outer part of the brachialis anticus, and also the supinator longus and extensor carpi radialis longior.

The *Cutaneous* branches of this nerve are the two external and one internal. The *two external cutaneous* branches pierce the outer head of the triceps at its humeral attachment. They are *superior* and *inferior*: the former runs down by the side of the cephalic vein to the front of the elbow, and supplies the skin of the lower half of the arm on its anterior aspect; the latter pierces the deep fascia below the deltoid insertion, and runs along the external surface of the arm and elbow to the back of the radial side of the forearm, where it will be subsequently seen.

The *Internal Cutaneous* branch is small, and arises with the internal muscular branch in the axilla. It passes across the posterior wall of the axilla to the inner side of the arm, where it becomes subcutaneous, and supplies the skin on the posterior aspect of the arm nearly to the olecranon.

The *Radial* and *Posterior Interosseous* nerves are distributed to the forearm, and will be dissected with it.

The *Sub-Anconeus* is a small muscle beneath the triceps, near the elbow, and is distinct from it, and will be seen on removing the triceps from the lower part of the humerus. It consists of an outer and inner slender fasciculus, which arise from the humerus just above the olecranon fossa, and are inserted into the upper part of the posterior ligament of the elbow joint. It corresponds to the *sub-crureus* in the lower part of the front of the thigh.

Nerve.—Musculo-spiral.

Action.—It raises the posterior ligament, and with it the synovial membrane, when the joint is extended.

Dissection.—The *shoulder joint* should now be examined, and to do this the tendons of the muscles passing across it from the scapula to the humerus must be separated from the capsule with care, as some of them are intimately blended with it. Before opening the capsule the dissector should move the humerus in various directions, to ascertain what parts are rendered tense or lax in the many motions of the joint. He may also distend the capsule with air or water, or warm tallow, so as to observe any processes of the synovial membrane.

Movements.—This articulation is susceptible of great motion in every direction, but superiorly and posteriorly motion is rather limited by the margin of the acromion. Abduction, adduction, forward and backward motion, circumduction and rotation, are permitted. In the to-and-fro or antero-posterior and swinging movement, the head of the humerus rests on the deepest part of the glenoid fossa, and turns forwards and backwards on a line through the axes of the head and neck, and will not be displaced by the speed or degree of the movement. The anterior movement is termed *flexion* and is less limited than the posterior, which is *extension*. In extreme flexion the scapula follows the movement of the humerus, and rotates on its axis so as to keep the centre of the glenoid fossa applied to the humeral head. In this extreme movement the scapula does not follow the humerus, so that dislocation downwards is likely to occur. In flexion the posterior and inferior parts of the capsule are rendered tense, and also the posterior muscles; and the reverse occurs in extension, the muscles having more power than the loose capsule in controlling these motions.

Abduction and *Adduction.*—The former consists in raising the humerus laterally from the thorax, and the latter in drawing it towards

the trunk. In both cases the head of the humerus rolls down in the glenoid cavity, in the first motion, and up in the latter. The scapula moves but slightly in these movements.

In *Abduction* the lower part of the capsule is rendered tense, and the head of the humerus descends to the lower larger part of the glenoid fossa, and projects beyond it against the capsule. Extreme abduction being limited by the contact of the great tuberosity with the outer margin of the acromion, dislocation downwards (into the axilla) is liable to occur if this movement be forced to an extreme.

In *Adduction*, which is limited by the contact of the humerus with the trunk, the lower part of the capsule is rendered again lax, and the head of the bone rises on the glenoid fossa. Extreme adduction, in front or behind the chest, is checked by the upper, front and back portions of the capsule and by its accessory ligaments, which are rendered tense. The muscles attached to the tuberosities also check these motions.

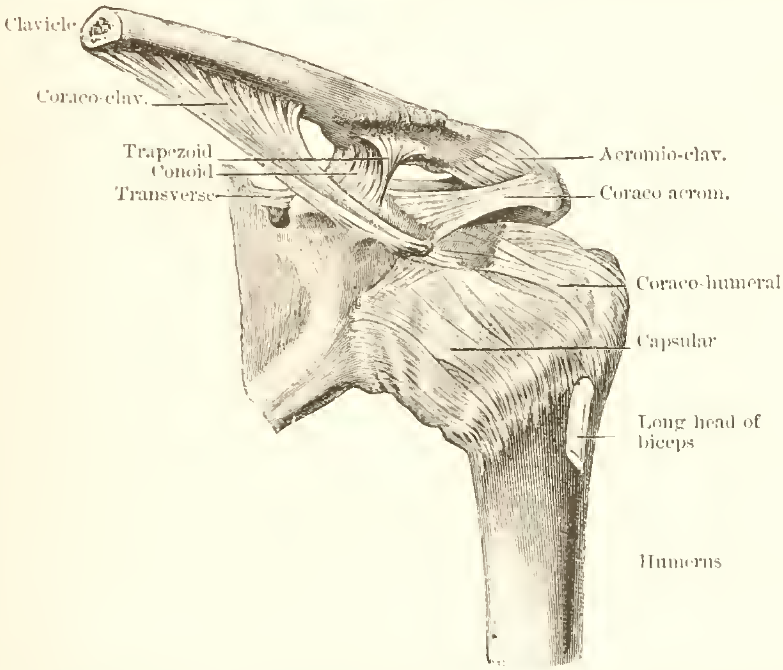


FIG. 104.—LIGAMENTS OF LEFT SHOULDER JOINT AND BETWEEN CLAVICLE AND SCAPULA.

In *Circumduction*, which may be said to be a combination of flexion, extension, abduction, and adduction, the humerus describes a cone whose base is at the fingers, and apex at the glenoid cavity. It is of course freest with the arm slightly separated from the side.

Rotation.—This is of two kinds, internal and external, and the motions of the head and shaft of the humerus vary.

In *Internal Rotation* the humeral head passes from before back, across the glenoid cavity, and projects behind, rendering the back of the capsule tense; the shaft at the same time moves forwards around a line which passes on its inner side from the cartilaginous portion of the head to the inner condyle, the great tuberosity being turned forwards.

In *External Rotation* the motions are reversed. The head rolls forwards, projecting in front, and rendering the anterior part of the

capsule and its accessory ligaments tense; the shaft is moved back around the line before mentioned, and the great tuberosity is revolved backwards.

The muscles are the main agents in limiting all these motions, but the upper thicker part of the capsule, with the anterior and posterior parts just mentioned, assist in checking the movements.

The **Shoulder Joint.**—This is an arthrodial or ball-and-socket joint, and the large rounded head of the humerus, with the shallow glenoid fossa of the scapula, enters into its foramen. The bones are kept in position by the tensity of the surrounding muscles and by atmospheric pressure, and not by the tension of its ligaments, which are loose, and which, if tense, would restrict the movements of the joints. Its ligaments are *capsular*, *coraco-humeral*, *gleno-humeral*, and *glenoid*, the two former being *extra-* and the two latter being *intra-articular*.

The *Capsular Ligament* loosely surrounds the articular ends of the bones. It is strengthened by processes from the neighbouring tendons

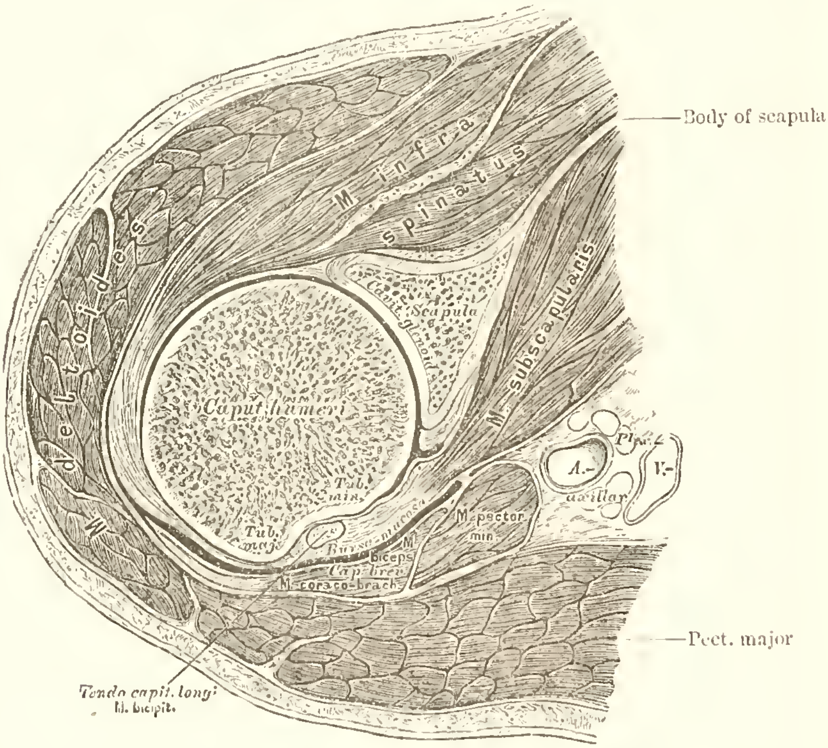


FIG. 105.—ANTERO-POSTERIOR TRANSVERSE SECTION THROUGH THE RIGHT SHOULDER TO SHOW ITS RELATIONS.

and is thicker above than below. Above it is attached to the circumference of the glenoid cavity rather beyond the glenoid ligament, being partly blended with it, and below it is fixed to the anatomical neck of the humerus, being nearer to the articular cartilage above than in the rest of its attachment, and is strongest at its upper aspect. It is sufficiently loose to allow of the separation of the humerus from the scapula for about an inch if the muscles be cut. It is pierced opposite the bicipital groove by the long head of the biceps, and below it is connected with the long head of the triceps. It usually has three openings, one on the inner side below the coracoid process for the bursa or synovial process under the subscapularis tendon; another, which is inconstant, at the outer and back

part which communicates with the synovial process or bursa under the infra-spinatus, and a third, which has been before mentioned, for the long head of the biceps.

The *Coraco-Humeral* or *Accessory Ligament* of the capsule is a thick band of fibres extending obliquely over the upper and anterior part of the capsule. It arises from the root of the coracoid process, and passes obliquely down and out to the margins of the bicipital grooves and to the tuberosities, blending with the tendon of the supra-spinatus, and partly with that of the subscapularis. A few fibres of this accessory process project into the joint, and are inserted to the inner and upper part of the bicipital

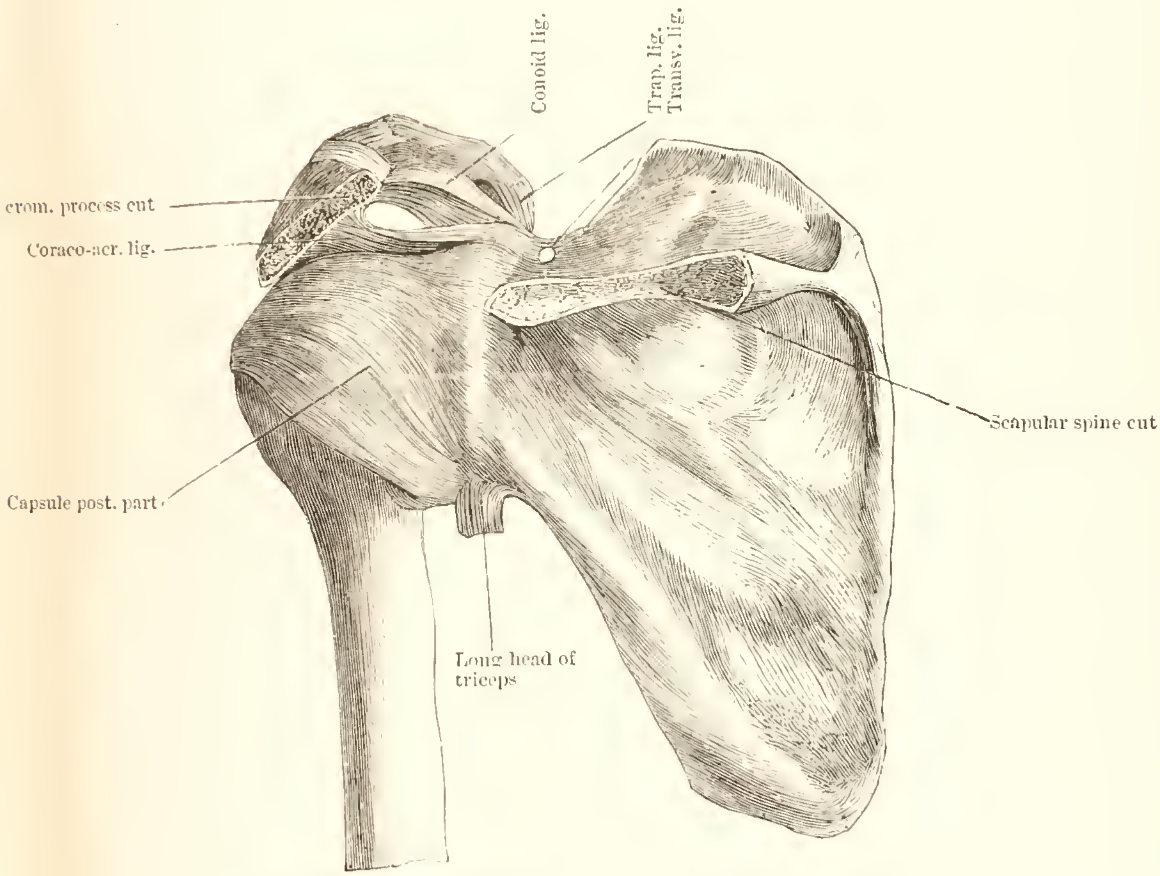


FIG. 106.—LEFT SHOULDER JOINT. POSTERIOR VIEW.

Scapular spine partly removed.

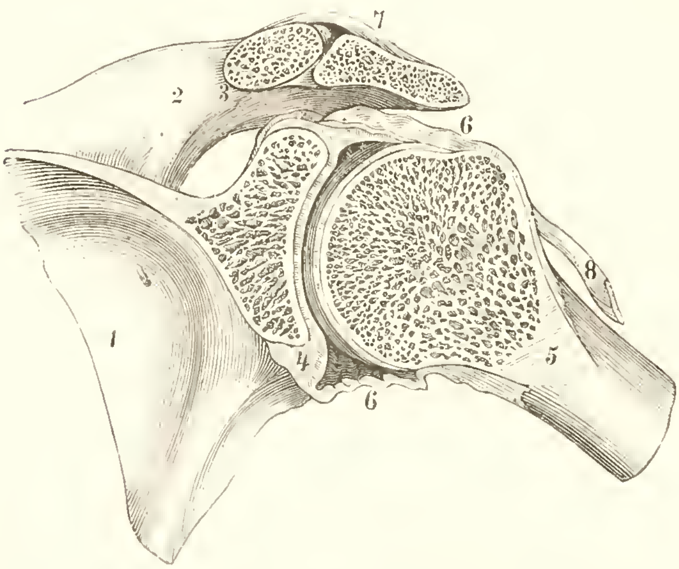
groove. These have been called the *gleno-humeral ligament*, and are said to correspond with the ligamentum teres of the hip-joint.

Relations.—In *front* and *internally*, is the subscapularis; *behind*, are the infra-spinatus and teres minor; *above*, the supra-spinatus; and *below*, the long head of the triceps. The long head of the biceps is first antero-external to the joint, and then within its capsule. The bony arch above is formed by the acromion and outer end of the clavicle, and the coraco-acromial ligament is above it. The deltoid caps all these structures, being separated from them by a large multilocular bursa.

Dissection. Divide the capsule near its scapular attachment, being careful to stop within a quarter of an inch in front and behind the long

tendon of the biceps. Reflect the capsule up and down, note its bony attachments, and the bifurcated insertions and relations of the long tendons of the biceps to the synovial membrane. This tendon is rounded and acts as a ligament, restraining motion upwards and outwards. Divide this ligament and separate the articular surfaces; the glenoid ligament will then be exposed.

The *Glenoid Ligament* is a fibro-cartilaginous band about two lines thick. It is attached round the margin of the glenoid cavity of the scapula, serving to deepen it for the reception of the head of the humerus. It is connected above with the tendon of the biceps, which bifurcates into two fasciculi at the upper part of the glenoid fossa within the capsule, and encircles the margin of the cavity and reunites at its lower part. The biceps tendon assists the glenoid ligament in deepening the fossa and in protecting the edges of the bone. The fibres of the glenoid ligament



1. Scapula.
2. Spine of same.
3. Acromial end of clavicle cut, and to its outer side the acromion cut.
4. Glenoid lig.
5. Humerus.
6. Capsule.
7. Acromio-clav. lig.
8. Long tendon of biceps attached to upper edge of glenoid cavity, which, with the head of humerus, is sawn through. The synovial cavity and articular cartilages are shown.

FIG. 107. VERTICAL LONGITUDINAL SECTION THROUGH LEFT SHOULDER, THE HUMERUS PARTLY ABDUCTED. ANTERIOR VIEW, ONE-HALF.

interlace, and it is triangular on section, the apex surrounding the head of the humerus and the base being attached to the bony margin of the glenoid cavity.

The *Synovial Membrane* lines the margin of the glenoid cavity, and is reflected over the inner surface of the capsule, covers the sides and lower part of the humeral neck, passing for a short distance over the cartilage covering the head of the bone, surrounds the long tendon of the biceps by a tubular sheath from the synovial cavity of the joint, and communicates with the bursa beneath the subscapularis tendon by an opening at the inner side of the capsule, and occasionally at its outer and back part with another bursa beneath the tendon of the infra-spinatus. The synovial sheath investing the long head of the biceps is continued down beyond the capsule into the bicipital groove, and is thence reflected up on it to its origin, where it is again continuous with the general synovial membrane of the capsule. The process of synovial membrane under the subscapularis may communicate with the subscapularis bursa, when present, or may take its place, forming a large pouch on the venter of the scapula.

A *sub-acromial bursa* described as lying beneath the deltoid, separating it from the capsule, and passing between the contiguous surfaces of the coracoid and acromial processes and coraco-acromial ligament, permits free motion of the shoulder without friction against the parts just mentioned.

The *Arteries* supplying this joint come from the supra-scapular, acromio-thoracic, and anterior and posterior circumflex.

The *Nerves* come from the circumflex and supra-scapular.

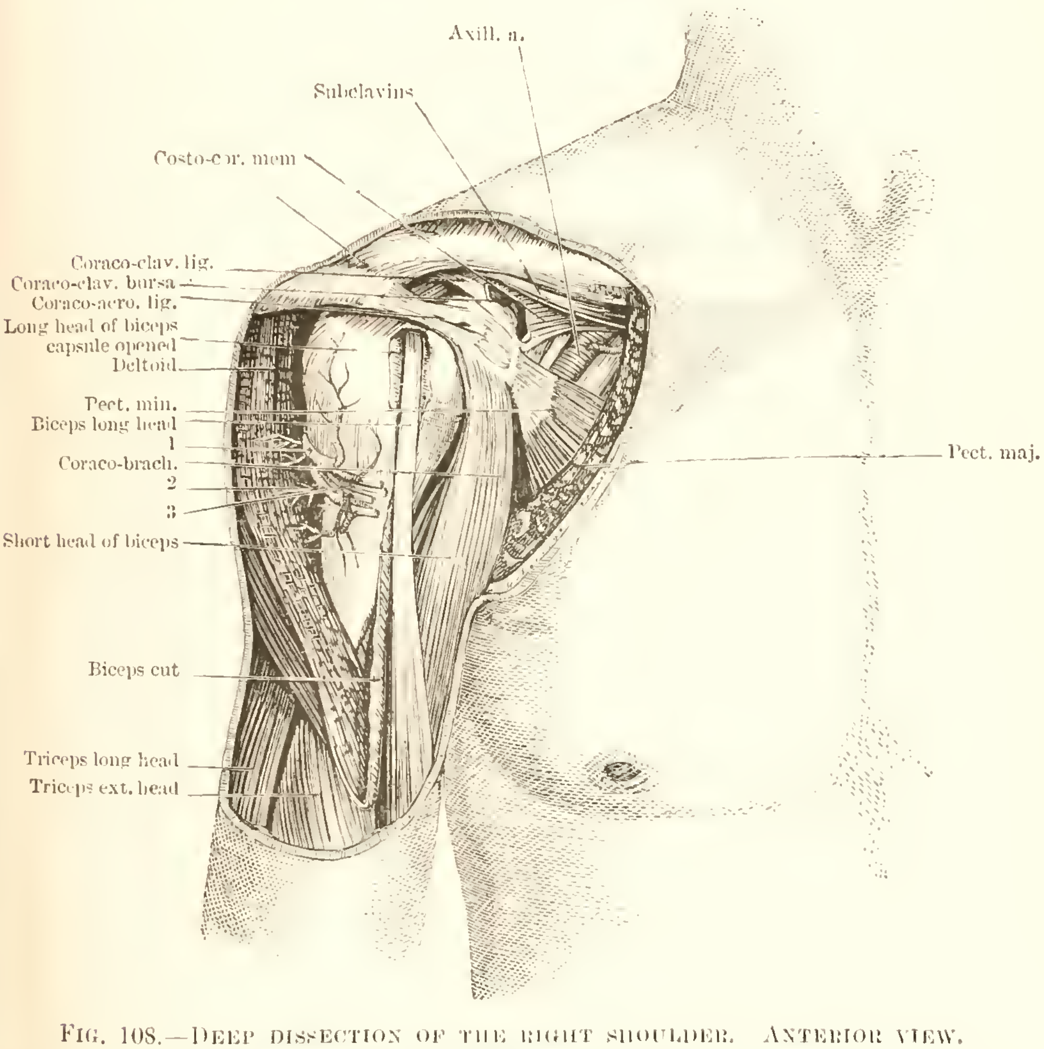


FIG. 108.—DEEP DISSECTION OF THE RIGHT SHOULDER. ANTERIOR VIEW.

1 2 3. Posterior circumflex vessels and nerve. The axillary artery is giving off the superior thoracic, and has the vein to its inner, and cords of brachial plexus to its outer, side. The deltoid is cut and pulled outwards. The dark space between the humerus, deltoid, and circumflex vessels represents the sub-deltoid bursa.

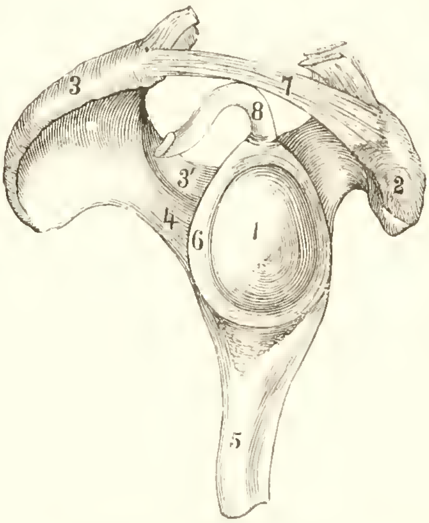
Articular Surfaces.—The joint surfaces of the humerus and glenoid cavity are covered by cartilage. That on the humeral head is thicker at the centre than at the circumference, and the opposite condition prevails in the glenoid cavity. The *humeral head* is two or three times larger than the glenoid cavity, and forms nearly half a sphere, and is joined to its shaft at a slight angle, which allows of considerable circumductory and rotatory motion.

The *Glenoid Fossa* of the scapula is oval with its large end downwards,

is very shallow, and is neither large nor deep enough to embrace the humeral head.

Surgical Applications.—The upper end of the humerus may be dislocated forwards, downwards, or backwards. A partial upward dislocation has been spoken of. A complete upper one would be impossible without fracture of the acromial process. After these dislocations have been reduced, the arm must be fixed to the side, because anatomy teaches that in that position the muscles and ligaments are at rest.

The humerus may also be broken high up, either within the capsule at its anatomical neck, which is rare, or, more commonly, at its surgical neck, which is common. In the latter accident displacement is considerable, and may resemble luxation of the humerus into the axilla. The upper fragment is somewhat drawn up under the coraco-acromial ligament by the subscapularis, supra- and infra-spinatus and teres minor, and the lower fragment is drawn in, and slightly down, by the pectoralis, teres major and latissimus dorsi; the distal portion of the broken bone is drawn obliquely out by the deltoid, but sometimes projects near the coracoid



1. Glenoid fossa.
2. Coracoid process.
3. Acromion.
3′. Scapular spine.
4. Arched outer border of same.
5. Axillary border of scapula.
6. Glenoid lig.
7. Coraco-acromial lig.
8. Long head of biceps. Above are cut.

FIG. 109.—SHOWING THE GLENOID CAVITY AND LIGAMENTS

process, being pulled up and in by the clavicular portion of the pectoralis major.

If the shaft of the humerus be broken below the insertion of the pectoralis and teres major and latissimus dorsi, and above the insertion of the deltoid, there is also much deformity. If the fracture be an oblique one, then the upper fragment is drawn in by the muscles just mentioned, as attached in or to the margins of the bicipital grooves, and the lower fragment is drawn up and out by the deltoid. The limb is shortened, and a projection is formed at the seat of fracture by the riding of the broken ends upon each other.

In transverse fractures just below the deltoid insertion the displacement is slight, the upper fragment being drawn a little forwards by the inner head of the brachialis anticus; but if oblique, the action of the biceps and brachialis anticus in front and the triceps behind draws up the lower fragment, gliding it either backwards or forwards over the superior fragment, according to the direction of the fracture. If this be obliquely

downwards and forwards, the distal fragment of the bone will be drawn upwards and backwards, and *vicê versâ*.

Fractures of the humerus just above the condyles may be mistaken for dislocation of both bones of the forearms backwards, or for separation of the articular epiphysis, of the humerus. If the fracture be oblique from above downwards and forwards, the lower fragment is drawn up and back by the muscles passing over the elbow joint in front and behind, viz. in the former situation, by the brachialis anticus, and in the latter, by the triceps. If the direction of the fracture be opposite to that just mentioned, the lower fragment is drawn up and forwards by the brachialis anticus and biceps, and the upper fragment projects back beneath the tendon of the triceps. The upper end of the lower fragment will cause a forward projection in this case, as it would a backward in the former injury.

The long tendons of the biceps may be ruptured, causing loss of motion, pain, and effusion into the joint of the bursa about the shoulder, may enlarge or inflame, and if they communicate with the joint may cause inflammation of it.

THE BACK OF THE FOREARM AND HAND.

Directions.—The limb must remain on its anterior aspect, but a small block must be placed beneath the wrist to render the muscles tense. Before reflecting the skin the student must make himself familiar with the surface markings. He should recapitulate the bony prominences and depressions about the elbow joint, which are given in the beginning of this chapter, and, after having studied the various landmarks, must reflect the skin as directed.

Surface Markings of the Forearm and Hand.—The *bony prominences* are formed by the radius and ulna. The upper half of the radial shaft is covered by muscles and can only be felt by making deep pressure. Its head may be felt by pressing the thumb deeply in front and just below the outer condyle, and posteriorly, in the groove below the outer condyle on the outer side of the olecranon. Its lower half is more superficial and can easily be made out, especially immediately above and below where the extensors cross it. Its lower extended portion and styloid process are quite subcutaneous, the posterior aspect of the former being grooved for the extensors of the thumb and radial side of the wrist. The radial styloid process is lower and more anterior than that of the ulna. The bony margins of the groove for the extensor secundi internodii pollicis can be made out.

The ulna is subcutaneous in its whole length, and its head can be plainly seen and felt projecting at the back and inner side of the wrist, especially if the hand be pronated and flexed. Its styloid process is higher and posterior to that of the radius. This allows greater adduction of the hand. The apex of the styloid process is on a level with the inferior radio-caupal joint, and the head is grooved posteriorly for the extensor carpi ulnaris. A *subcutaneous bursa* is often found over it, and another over the back of the radius. These, when enlarged, have been mistaken for effusion into the synovial sheaths of the tendon.

Bony Markings on the Wrist and Hand.—Below the styloid process

of the radius, and internal to the thumb extensors, is the tubercle of the scaphoid, and between the two is the back of the radio-carpal joint, a little below which is the trapezium. The cuneiform may be felt about an inch below the styloid process of the ulna, at the back of the wrist, and the pisiform is about the same distance below the ulnar head on the front of the inner side of the wrist. This little bone is movable, having a separate joint, with the cuneiform, and the tendon of the flexor carpi ulnaris is inserted into it. The bases of the metacarpal bones of the fingers can be felt on the dorsum of the hand, and the articulation between the metacarpal bone of the thumb and the trapezium can be made out about an

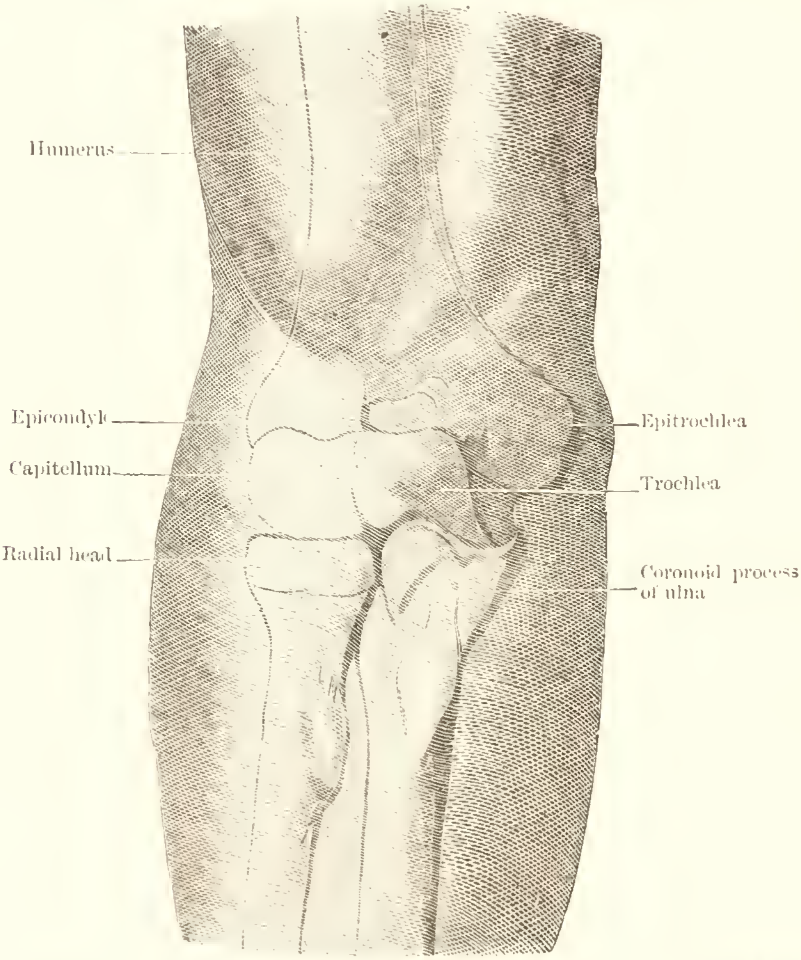


FIG. 110.—THE RELATION OF THE RIGHT ARM-BONES TO THE SURFACE. ANTERIOR ASPECT.

inch below the styloid process of the radius. The unciform process of the unciform can be felt in the palm on making deep pressure about half an inch below and to the outer side of the pisiform. The heads of the metacarpal bones can be plainly felt, and are well seen on the posterior aspect during flexion of the metacarpo-phalangeal joint. They form the prominences of the knuckles. The bases, shafts, and heads of the phalanges can usually be distinctly felt.

Muscular Prominences and Depressions, and Skin Furrows.—In front of the forearm, at its upper part, is the hollow formed by the muscles arising from the outer and inner condyles, and along its anterior aspect,

on the outer and inner sides, are two lateral depressions corresponding to the radial and ulnar arteries, the outer corresponding to the radial, the inner to the ulnar artery. The inner groove can be seen along the lower half of the forearm, and the outer one tends towards the middle of the limb near the elbow. On the back of the forearm and hand, the subcutaneous veins are larger and more numerous than on the anterior aspect, and beneath them, under the deep fascia, are the extensor muscles and tendons, and the space between the radius and ulna can be more plainly felt on this aspect in the lower half of the forearm.

On the outer side of the palm of the hand is a large projection, formed by the muscles of the thumb, called the *thenar eminence*, and on the inner side is the *hypo-thenar* eminence, formed by the muscles of the

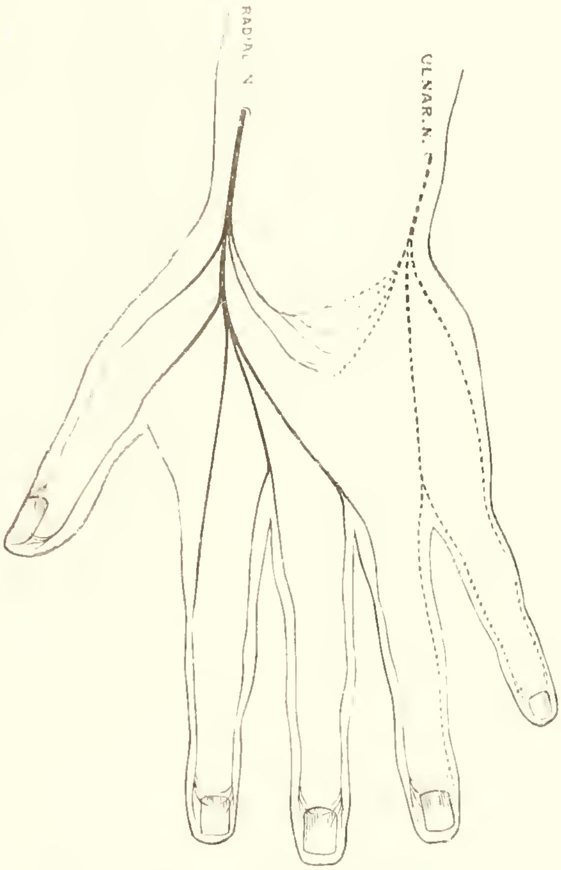


FIG. 111. DIAGRAM OF THE RADIAL AND ULNAR NERVES AND THEIR ANASTOMOSES. DORSAL ASPECT OF LEFT HAND.

little finger, and between the two is a groove, narrow near the wrist, which forms the hollow of the palm, beneath which is the middle portion of the palmar fascia. Two oblique and two transverse lines are seen in the palm which are usually of the shape of the italic letter *M*; the one nearer the finger tips corresponds to the front of the metacarpo-phalangeal articulation of the index and little fingers, but is about a quarter of an inch posterior to that of the two inner digits. There are also two lines on the skin on the anterior aspect of the lower end of the forearm, the lower being just above the inner and outer muscular prominences of the hand, and corresponds with the anterior aspect of the first row of carpal bones;

the other is about half an inch above it, and is more or less continuous with one on the back of the forearm, and corresponds to the lower portion of the radius and ulna. The anterior one corresponds to the radio-carpal articulation, and the posterior to the lower radio-ulnar joint. Transverse lines are seen on both aspects of the digits and thumb. Those on the palmar aspects of the fingers guide to their articulations; the first interphalangeal furrow being slightly in front of the larger or proximal transverse groove, and the joint between the last two phalanges is about a line in front of the main groove. There are also two or three transverse grooves near the bases of the fingers, on their palmar aspects on a level with the webs.

If the thumb be placed at right angles to the extended fingers, and a line drawn across the palm level with its lower border, it will very nearly

FIG. 112.—SUPERFICIAL LYMPHATICS OF BACK OF RIGHT FOREARM. THE DIGITAL PLEXUSES ARE SHOWN.

correspond with the superficial palmar arterial arch, a finger's breadth above which (i.e. that is nearer the wrist) is the deep arch.

Dissection.—After replacing the limb as directed, make an incision along the middle of the posterior aspects of the forearm, hand, and middle finger to the root of the nail; another across the back of the hand at the heads of the metacarpal bones, and, if necessary, another transverse one near the elbow. The skin should be reflected from the back of the thumb and fingers, and also from the back of the forearm, and the cutaneous vessels and nerves sought between the layers of the superficial fascia.

Superficial Fascia of the Forearm is continuous above with that of the

arm, and below with that of the hand. It contains fat between its layers, also the superficial vessels and nerves and lymphatics which pierce it to go to and from the skin. The superficial veins and lymphatics have already been described. The *superficial fascia on the dorsum of the hand* is thin, and placed between the tendons and vessels and nerves. It is continuous above with the posterior annular ligament, and below runs over the extensor tendons, and at the sides becomes gradually lost.

Cutaneous Nerves.—The *posterior branch* of the *internal cutaneous* nerve descends on the posterior surface of the inner side of the forearm to

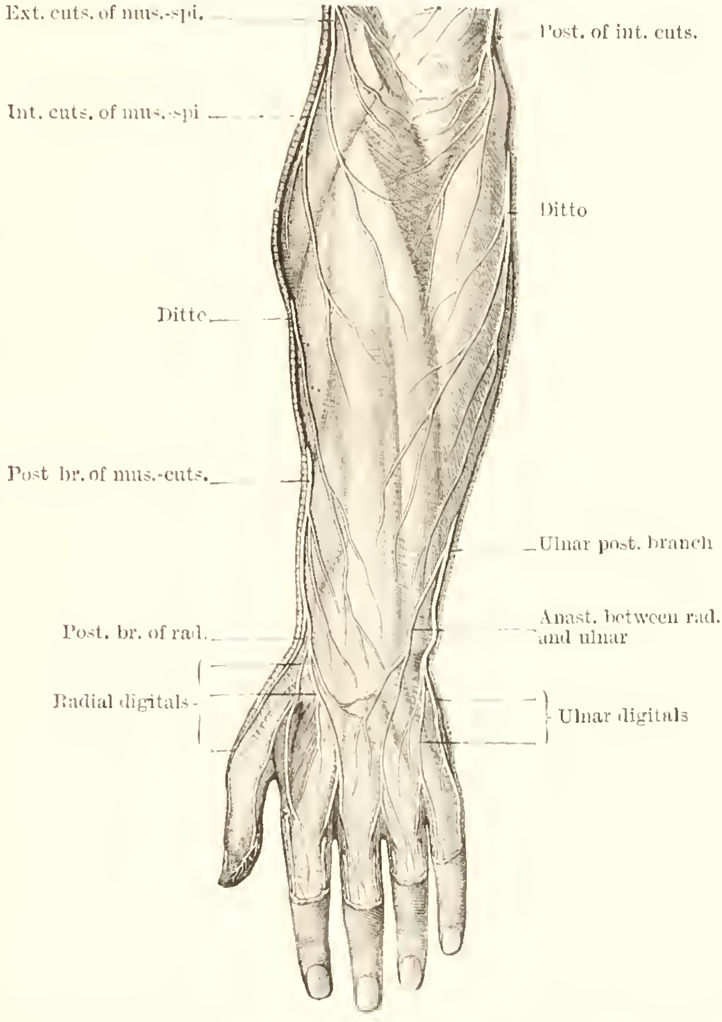


FIG. 113 – CUTANEOUS NERVES OF BACK OF LEFT FOREARM AND HAND. THE SKIN IS LEFT ON THE FINGERS.

a little below its middle; above the elbow it anastomoses with the lesser internal cutaneous, and above the wrist with the dorsal branch of the ulnar nerve.

The *Posterior Branch* of the *external cutaneous* nerve is given off about the middle of the forearm, and passes down along the back part of its radial border to the wrist, supplying the skin of the lower third of the forearm, and joining the lower external cutaneous of the musculo-spiral and the radial nerve.

The *Lower External Cutaneous Branch* of the *musculo-spiral* courses

along the back of the radial side of the forearm to the wrist, supplying the skin and anastomosing with the posterior branch of the external cutaneous nerve.

The *Superficial Parts of the Radial and Ulnar Nerves* will be seen piercing the deep fascia on the outer and inner sides of the limb, below the nerves just mentioned, the radial perforating the fascia higher than the ulnar, and about three inches above the wrist it divides into two branches, outer and inner.

The *External Branch* is the smaller, and supplies the skin on the radial side of the forearm and over the back and ball of the thumb, joining the posterior branch of the external cutaneous.

The *Internal Branch* joins above the wrist some filaments of the external cutaneous, and on the back of the hand, about its root, forms an arch with the dorsal branch of the ulnar nerve. It then divides into four digital nerves: the first supplies the inner side of the thumb; the second, the radial side of the index finger; the third, the contiguous sides of the

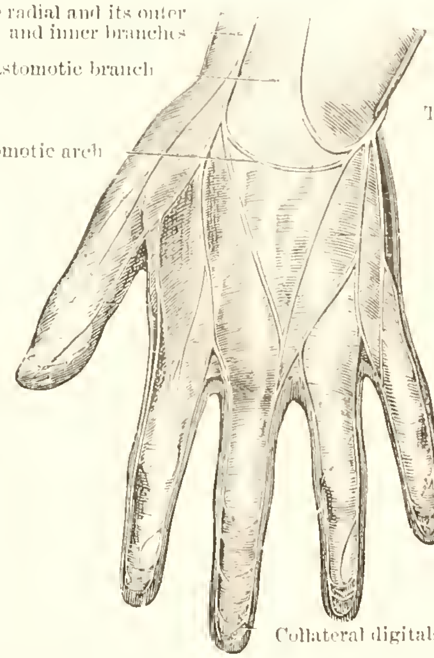


FIG. 111. NERVES ON THE DORSUM OF THE LEFT HAND AND FINGERS.

The loops and twigs at the end of the digitals are shown.

index and middle fingers; and the fourth, the adjacent sides of the middle and ring fingers. The last of these anastomoses with filaments from the dorsal branch of the ulnar. These dorsal digital nerves communicate on the sides of the fingers with the palmar digitals from the median and ulnar, and sometimes the contiguous sides of the middle and ring fingers are entirely supplied by the radial, and at other times, by the ulnar nerve.

Varieties.—The dorsal branch of the radial nerve occasionally supplies the whole of the back of the hand and fingers, and sometimes the dorsum is equally divided between it and the ulna.

The *Dorsal Cutaneous Branch* of the *ulnar nerve* is given off about two inches above the wrist, and after perforating the deep fascia runs along the inner side of the wrist and hand, and divides into two branches,

of which the inner supplies the ulnar side of the little finger, and the outer divides to supply the contiguous sides of the ring and little fingers, joining the innermost digital branch of the radial.

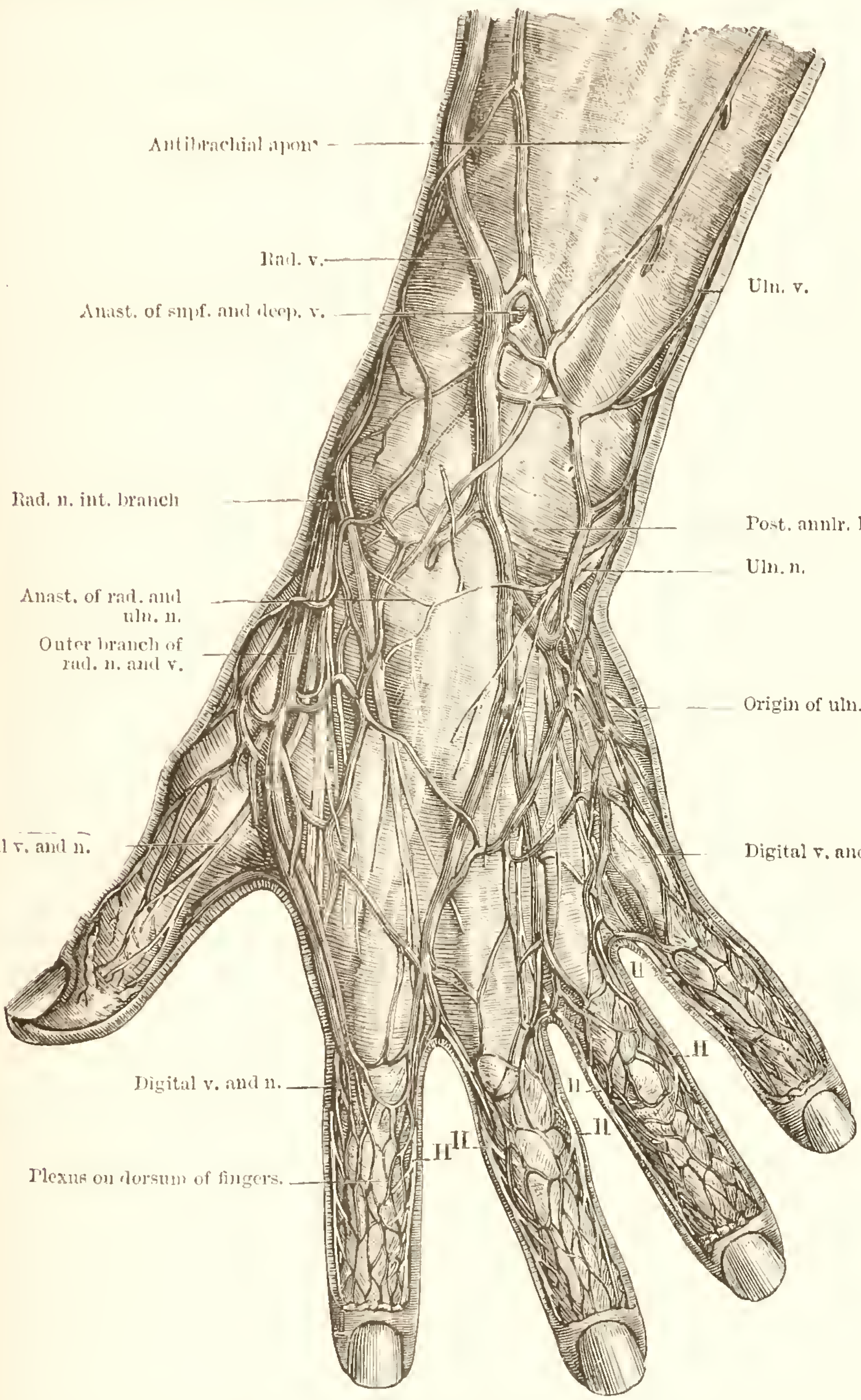


FIG. 115.—CUTANEOUS VEINS AND NERVES ON DORSUM OF LEFT HAND.

The oblique arches on the dorsum and the free anastomoses between the outer and inner veins are shown. H H H. Collateral digital nerves.

Cutaneous Veins.—The superficial veins on the back of the hand and forearm begin in the venules surrounding the fingers. These are joined

on the outer and inner sides by the dorsal vein of the thumb and little finger, and form oblique arches on the dorsum of the hand. The dorsal veins of the thumb and forefinger unite to form the *radial* and the dorsal vein of the little finger (*vena salvatella* of the old anatomists) forms the *posterior ulnar* vein. This ascends along the ulnar border of the forearm to below the elbow-bend, and joins the *anterior ulnar* vein to form the *common ulnar cutaneous* vein.

The **Deep Fascia** of the forearm is continuous with that of the arm, and below with the anterior and posterior annular ligament. It is a strong, glistening, aponeurotic structure, which encloses the muscles of the forearm, and from its inner surface sends septa between them. It consists of circular and oblique fibres joined by vertical ones, and is much thicker on the dorsal and lower part of the limb than on the palmar and upper parts. It is strengthened above and in front by expansions from the biceps and brachialis anticus, and from the triceps behind, being attached to the olecranon and posterior border of the ulna, at the upper and inner side of the forearm, giving origin to several antibrachial muscles. Transverse intermuscular septa are given off on the anterior and posterior aspects of the forearm, separating the superficial from the deep muscles. and there are many openings in it for the cutaneous vessels and nerves One, larger than the rest, is placed just below the front of the elbow, and transmits a largish communicating branch between the superficial and deep veins.

The **Posterior Annular Ligament** is a thickening of the deep fascia of the forearm, and extends transversely across the back of the wrist. It forms a sheath for the extensor tendons, and is attached, *internally*, to the ulna, the cuneiform and pisiform bones and inner piece of the palmar fascia; *externally*, to the outer margin of the radius, and *behind*, to the ridges on its posterior surface. It has six compartments for the passage of the extensor tendons, which will be subsequently examined.

Deep Fascia of the Back of the Hand.—This invests the dorsal interossei, being continuous, *anteriorly*, with the fascia or aponeuroses of the palmar interossei; *above*, with the posterior annular ligament; at the *sides* it is attached to the edges of the metacarpal bones; and *below* it passes on to the dorsum of the fingers over the sheaths of the extensor muscles.

Dissection.—The deep fascia must be removed by similar incisions to those through the skin, being careful of the posterior interosseous vessels, which lie along the outer side of the extensor carpi ulnaris in the lower third of the forearm. The deep surface of this fascia will be found intimately blended with the upper part of the muscles.

Superficial Muscles of the Posterior Antibrachial Region.—There are seven muscles in the superficial layer, most of which arise by a common tendon from the outer humeral condyle. They are placed in the following order from without inwards. First, the long supinator; then, the long and short radial extensors of the wrist, the common extensor of the fingers, the extensor of the little finger; and lastly, the extensor carpi ulnaris, near the upper part of which is the anconeus.

The **Supinator Radii Longus** is the most superficial muscle on the radial border of the forearm. Its upper two-thirds are fleshy, and its lower third tendinous. It arises from the upper two-thirds of the external condyloid ridge of the humerus, and from the front of the upper part of

the external intermuscular septum, being limited above by the musculo-spiral groove. The fibres end about the middle of the forearm in a flat

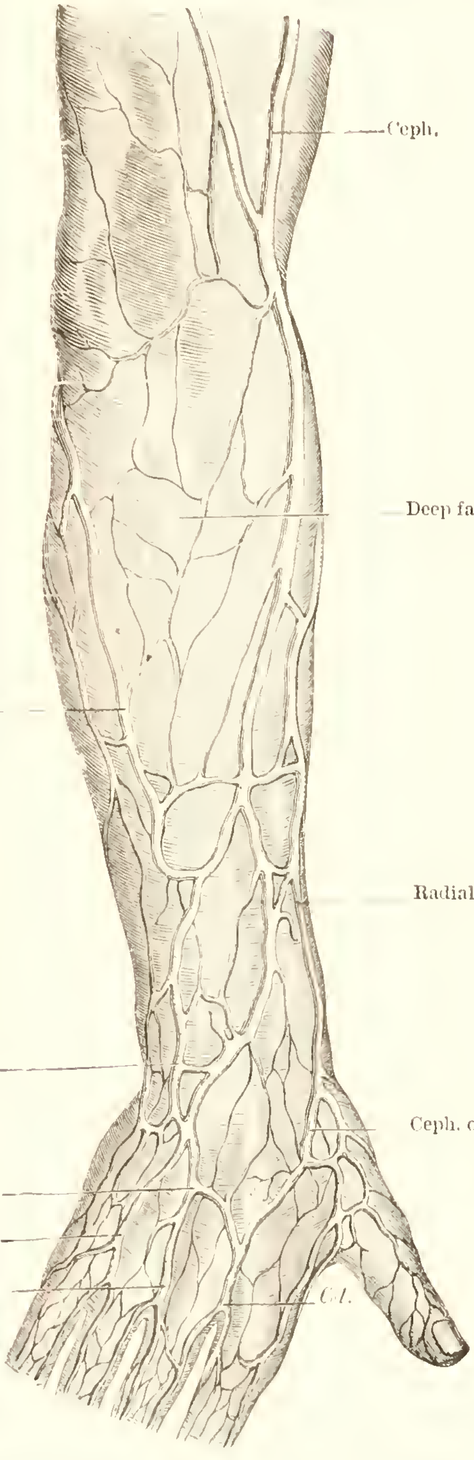


FIG. 116.—THE LARGER SUPERFICIAL VEINS AT BACK OF RIGHT FOREARM AND HAND.

The deep fascia is shown beneath the veins.

tendon, which arises from its deep surface, and is inserted into the base of the styloid process of the radius.

Relations.—Superficially, by the skin and fascia, and is crossed near its

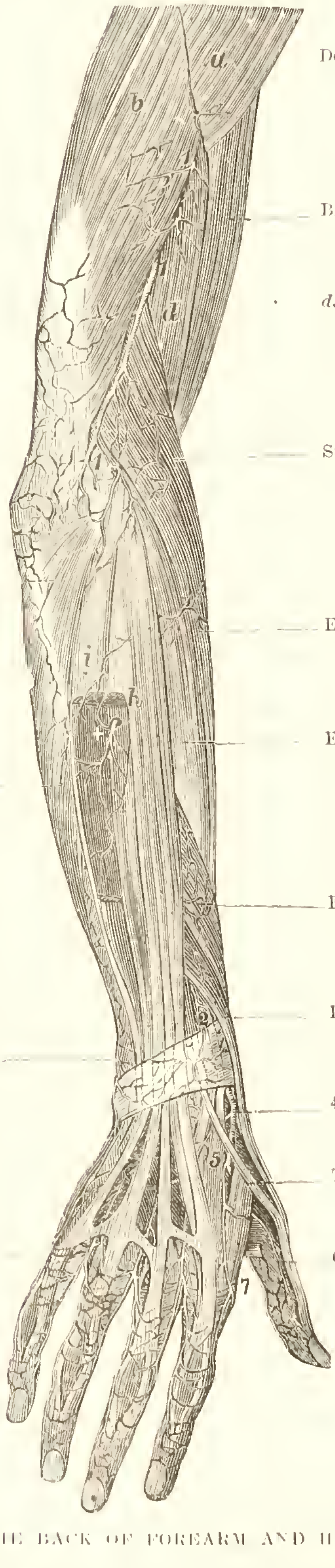


FIG. 117.—DISSECTION OF THE BACK OF FOREARM AND HAND AND OUTSIDE OF ARM.

The posterior dorsal arch and interossei are faintly shown. The white cross at middle of forearm shows where the posterior interosseous artery pierces the extensors coms. and carp. ulnaris.

insertion by the extensors ossis metacarpi pollicis and primi internodii pollicis. Its *deep surface* is in relation with the lower end of the humerus, the extensors carpi radialis longior and brevior, the supinator brevis, and the insertions of the pronator teres. Its *anterior border* touches the biceps and brachialis anticus; and between its *inner border* and brachialis anticus, above the elbow, are the musculo-spiral nerve, the superior profunda, and

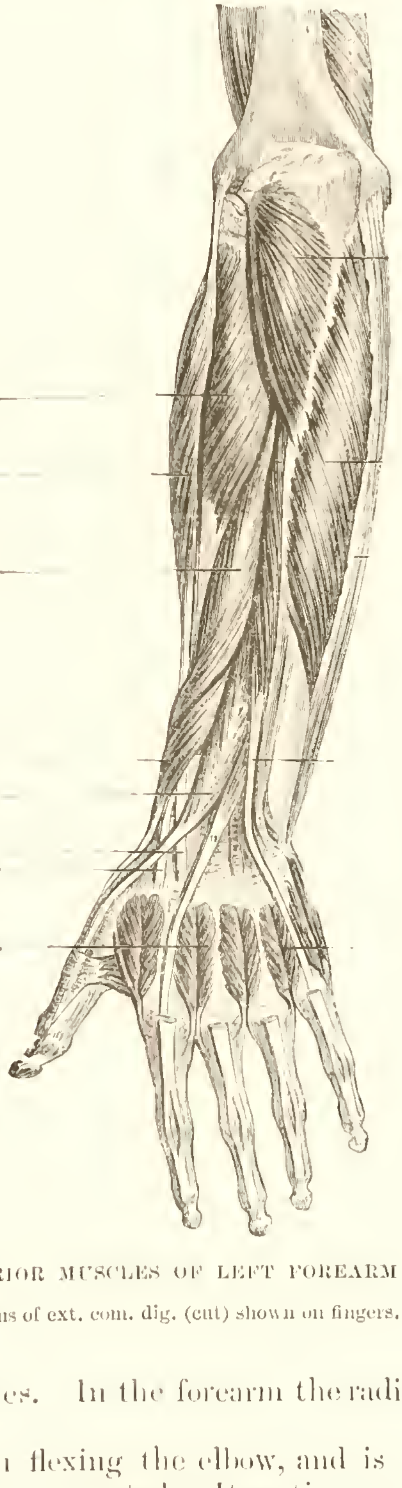


FIG. 118.—POSTERIOR MUSCLES OF LEFT FOREARM AND HAND.

Tendons of ext. com. dig. (cut) shown on fingers.

the radial recurrent arteries. In the forearm the radial vessels and nerves are on its *inner* side.

Actions.—It assists in flexing the elbow, and is a feeble supinator of the radius when it has been pronated. Its action as a flexor is more pro-

nounced after supination has taken place. If the radius be fixed, as in climbing, it will flex the elbow and bring up the humerus towards the

FIG. 119.—POSTERIOR MUSCLES OF THE LEFT FOREARM.

forearm. Duchenne, in his 'Physiologie des Mouvements,' regards it as assisting the pronators, and calls it a *flexo-pronator*.

Nerve.—A branch from the musculo-spiral.

Varieties.—Its origin is sometimes connected to some of the surrounding muscles, and its tendon may be divided into two or three slips, which are inserted together or at some distance from each other.

The **Extensor Carpi Radialis Longior** is beneath the preceding, and arises from the lower third of the external condyloid ridge, and from the intermuscular septum. Its fibres end about the middle of the forearm in a flat tendon, which accompanies that of the extensor carpi brevior beneath the posterior annular ligament in a groove on the back of the radius which is common to the two muscles, and is inserted into the radial side of the base of the second metacarpal bone on its dorsal aspect. There is usually a small bursa between the tendon and the bone near its insertion.

Relations.—*Superficially*, with the supinator longus and deep fascia; *deeply*, with the elbow joint, the extensor carpi brevior, posterior branch of the radial nerve and posterior ligament of the wrist. Its tendon is crossed obliquely by the extensor tendons of the thumb.

Action.—It first extends the wrist joint, and then flexes the elbow. With the arm raised, as in climbing, it will assist the long supinator in its action on the humerus.

Nerve.—The musculo-spiral.

Varieties.—Its tendon may be divided into two or three or more, and may be attached to the bases of the second or third metacarpal bones. Mr. Wood has described an additional muscle, an *extensor carpi radialis accessorius*, and I have several times seen it. It usually comes from the radius below the extensor longior, and runs along the same groove behind the radius on the outer side of the tendon of the longior, and is most commonly inserted into or near the base of the metacarpal bone of the thumb, but sometimes into the first dorsal interosseous muscle, abductor pollicis, or other part of the dorsum of the hand.

The **Extensor Carpi Radialis Brevior** is beneath the former muscle, and is thicker and shorter than it. It arises from the external condyle of the humerus by a tendon common to it and the extensors communis digitorum minimi digiti and carpi ulnaris, from the external lateral ligament of the elbow, from the intermuscular septum, and from a strong tendinous expansion on its surface. The fibres end about the middle of the arm in a flat tendon, which is closely connected to that of the extensor carpi longior, and passes with it beneath the posterior annular ligament in the same groove on the back of the radius, but on its inner side, and separating a little from its fellow, is inserted into the radial side of the base of the metacarpal bone of the middle finger on its dorsal aspect. There are usually two bursæ connected with this muscle, one at its upper part between it and the supinator brevis, and a smaller one below, between the bone and the tendon of insertion.

The tendons of the two radial carpal extensors of the wrist pass through the same compartment of the posterior annular ligament, have but one synovial membrane, and are separated by a small vertical bony ridge in the groove of the radius in which they lie.

Relations.—*Superficially*, with the extensor carpi longior and thumb extensors, which latter cross over it; *deeply*, with the supinator brevis, tendon of pronator teres, radius, and wrist joint. On its *ulnar border* is the extensor communis digitorum and the extensor secundi internodii tendon at the back of the wrist.

Actions.—It extends the wrist, but differs from the longior in *extending* instead of flexing the elbow.

Nerve.—The posterior interosseous.

Varieties.—Its tendon may divide into two or more slips, which may be inserted into two of the metacarpal bones, or a slip may pass to the fourth metacarpal.

The **Extensor Communis Digitorum** is placed between the extensors carpi brevior and minimi digiti, and is single at its origin, but divided into four tendons below. It arises from the external condyle by the tendon common to it and the other superficial extensors, from the intermuscular septum, and from the deep fascia. Just below the middle of the arm it sends in three or four tendons, which pass with the extensor indicis through

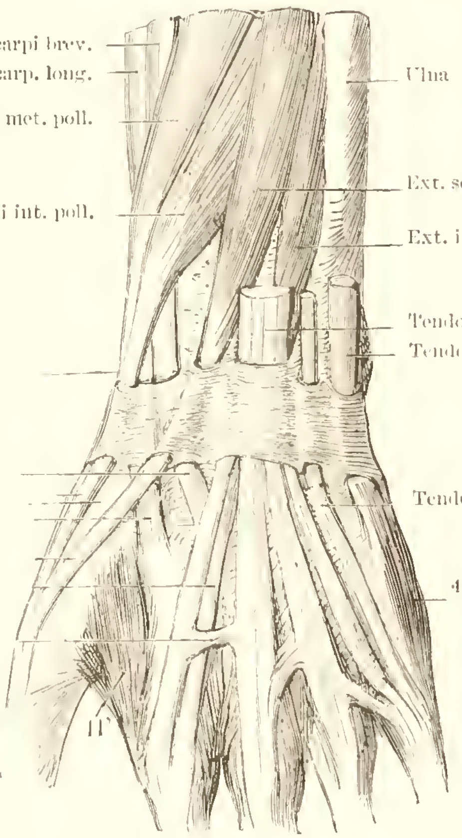
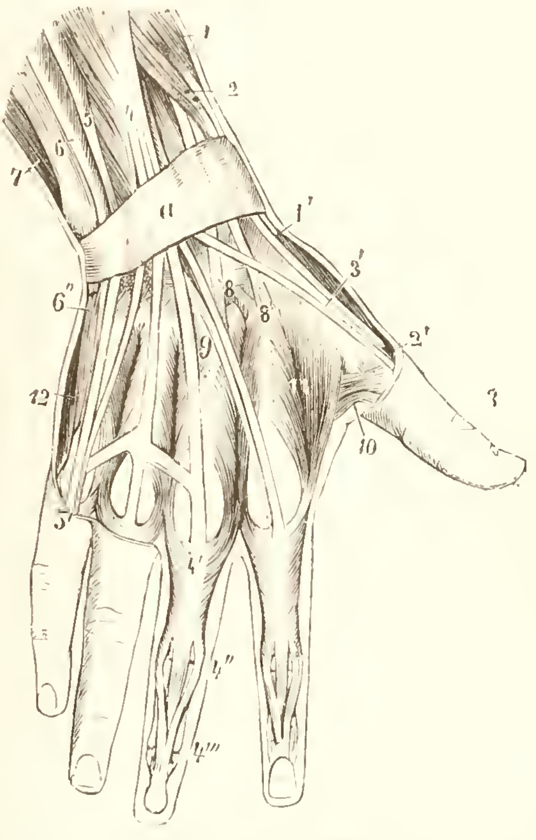


FIG. 120.—POSTERIOR MUSCLES OF THE LEFT FOREARM AND TENDONS PASSING UNDER POST-ANNULAR LIGAMENT.

a separate partition beneath the posterior annular ligament and in the innermost broad groove on the back of the radius. The tendons diverge as they pass to their insertions. There is one synovial membrane for the tendons of the two muscles. The innermost tendon divides into two after escaping from the posterior annular ligament, and all of them are inserted into the dorsum of the second and third phalanges in the following way: opposite the metacarpo-phalangeal articulation each tendon becomes narrower and thicker, and gives off a thin fasciculus upon each side of the joint; these, and the tendon, serve as the posterior ligament of the metacarpo-phalangeal and interphalangeal articulations. On the dorsum of

the first phalanx the tendon expands into a broad aponeurosis which covers the whole of the dorsum of the first phalanx, and is strengthened here by tendinous expansions from the lumbricales and interossei muscles; this expansion covers the dorsum of the second phalanx, and ends upon the third. Opposite the first interphalangeal articulation this aponeurotic tendon divides into three slips, a middle and two lateral. The central is much thinner than the others, and is inserted into the base of the second phalanx; the two lateral fasciculi, passing on, unite by their contiguous margins, and are inserted into the base of the dorsum of the last phalanx. On the index and little fingers the tendons before dividing are joined on their inner sides by the special extensors for those digits. On the back of the hand the ring-finger tendon gives off two processes, one on each side, called the



a. Post. ann. lig.
1. Ext. oss. met. poll.
1′. Insertion of oss. met. poll.
2. Ext. prim. intnod. poll.
3 and 3′. Tend. of ext. secund. intnod. poll.
4. Ext. com. dig.
4′. Its middle finger tendon joined by second and third intoss.
4″. The three divisions of the tendons
4‴. Insertion of lateral slips.
5. Ext. min. dig.
5′. Union of ext. min. dig. with ext. com.
6. Ext. carp. uln.
6′. Its insertion.
7. Flex. carp. uln.
8. Ext. carp. rad. brev.
8′. Ext. carp. rad. long.
9. Ext. indicis.
10. Abd. poll. and deep head of flex. brev. poll.
11. First dors. intoss.
12. Abd. min. dig.

FIG. 121.—TENDONS AND MUSCLES AT BACK OF THE RIGHT HAND.

The union of the tendons of the third, fourth, and fifth fingers is shown. The insertions of the first, second, and third *palmar* interossei are seen, from without inwards, in the outer three interosseous spaces.

vincula. These pass obliquely down to the tendons of the middle and little fingers. In consequence of this condition, the tendon of the ring-finger is held down as it were, and cannot be extended unless they also are extended. The tendon of this muscle for the index finger is only united to that for the middle finger by loose semi-transparent transverse bands of fibres, and is free in its action.

Relations.—Superficially, with the skin, deep fascia, extensor carpi longior and posterior annular ligament; *deeply*, with the supinator brevis, the extensors of the thumb and index finger, the posterior interosseous

vessels and nerve, the posterior ligament of the wrist, carpus, metacarpus, and phalanges; by its *outer border*, with the extensor carpi brevior; and by

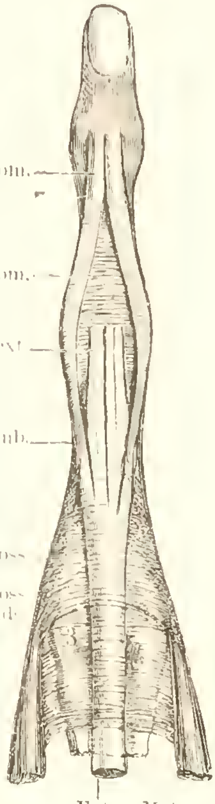


FIG. 122.—DORSAL ASPECT OF A FINGER SHOWING ARRANGEMENTS OF TENDONS.

its *inner*, with the extensor minimi digiti and extensor carpi ulnaris.

Action.—It extends or straightens the three phalanges from root to

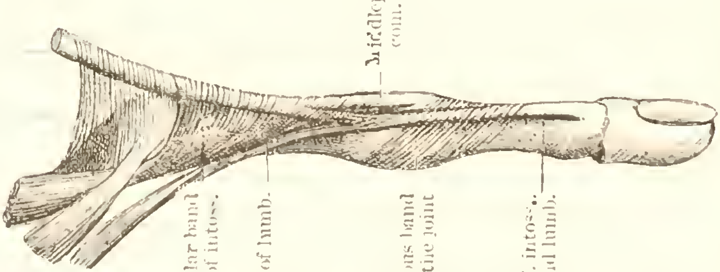


FIG. 123.—LATERAL VIEW OF A FINGER, THE EXTENSOR TENDON RAISED.

tip and separates the fingers from each other. It can extend the proximal phalanx whilst the two others are flexed, and it can straighten the two

distal phalanges when the proximal is bent. It assists the other extensors of the wrist and elbow if the fingers have been extended. Some writers say that it only extends the first phalanx.

Nerve.—The posterior interosseus.

Varieties.—These consist in a deficiency or excess of its tendons of insertion and of its muscular substance. Sometimes there are two tendons to each finger, and sometimes even three to each, but more commonly the increase is limited to the index and little fingers, or only to one of them.

The **Extensor Minimi Digiti** is the smallest muscle on the back of the forearm. It is on the innerside of the extensor communis, with which it is generally connected, and appears to be but a portion of it. It *arises* by a thin tendinous slip from the common tendon, and from the intermuscular septa. Its tendon, which begins in the lower quarter of the arm, runs through a separate compartment beneath the posterior annular ligament behind the inferior radio-ulnar joint, between the two bones of the forearm, and divides into two on the back of the fourth metacarpal bone, and at the metacarpo-phalangeal articulation joins the tendon of the com-

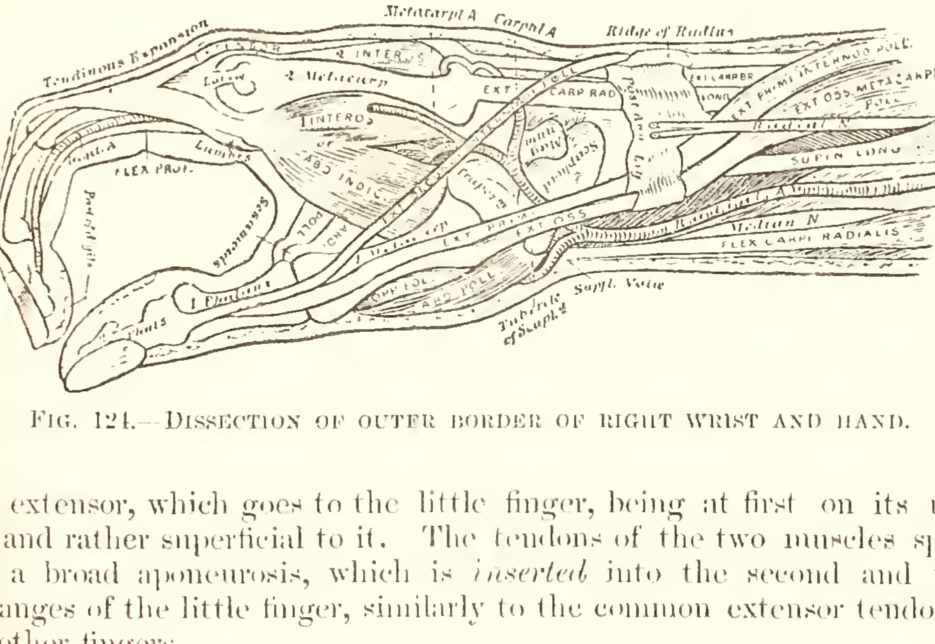


FIG. 124.—DISSECTION OF OUTER BORDER OF RIGHT WRIST AND HAND.

mon extensor, which goes to the little finger, being at first on its ulnar side and rather superficial to it. The tendons of the two muscles spread into a broad aponeurosis, which is *inserted* into the second and third phalanges of the little finger, similarly to the common extensor tendons of the other fingers.

Relations.—*Superficially*, with the skin and extensors communis digitorum and carpi ulnaris; and *deeply*, with the supinator brevis, extensors of the thumb, posterior ligaments of the wrist and of the phalangeal joints. To its *inner border* is the extensor carpi ulnaris, and to its *outer* the tendons of the extensor communis digitorum.

Action.—It extends the little finger and then the wrist and elbow, and in consequence of the tendon being split, the inner piece can straighten the little finger in spite of the junction of the outer piece with the common extensor.

Nerve.—The posterior interosseus.

Varieties.—It may be entirely absent or may resemble the extensor communis, or the indicis, in an increase of its tendons of insertion. Frequently an additional tendon is inserted into the ring-finger.

The **Extensor Carpi Ulnaris** is the most internal of the muscles on the back of the forearm. It *arises* by the common tendon from the external humeral condyle, from the deep fascia, intermuscular septa, and from the middle third of the posterior border of the ulna below the anconeus. Its fibres end in a tendon which is on its posterior surface and passes through a groove on the back of the ulna, in a separate partition beneath the posterior annular ligament, and is *inserted* into the ulnar side of the base of the metacarpal bone of the little finger, on its dorsal aspect.

FIG. 125.—POSTERO-LATERAL VIEW OF LEFT ULNA.

Relations.—Superficially, with the skin and fascia; and *deeply*, with the extensors of the thumb and ulna. On its *outer* side in the lower third of the arm are the posterior interosseous vessels and the extensor minimi digiti, and the ulna is to its *inner* side.

Actions.—It extends the wrist on its ulnar side and adducts the hand; it can then extend the elbow.

Nerve.—Posterior interosseus.

Varieties.—It is often connected with the abductor minimi digiti—

sometimes joins the extensors on the dorsum of the little finger. This slip has been named the *ulnaris quinti*.

The **Anconeus** is a small triangular muscle behind and below the elbow joint, and seems to be a continuation of the outer portion of the triceps. It *arises* by a separate tendon from the back of the outer condyle of the humerus and on the ulnar side of the common extensor tendon; the fibres then diverge, the upper ones passing transversly and the lower obliquely, to be *inserted* into the outer side of the olecranon and upper third of the posterior surface of the shaft to the ulna.

Relations.—Superficially, is a strong fibrous expansion from the

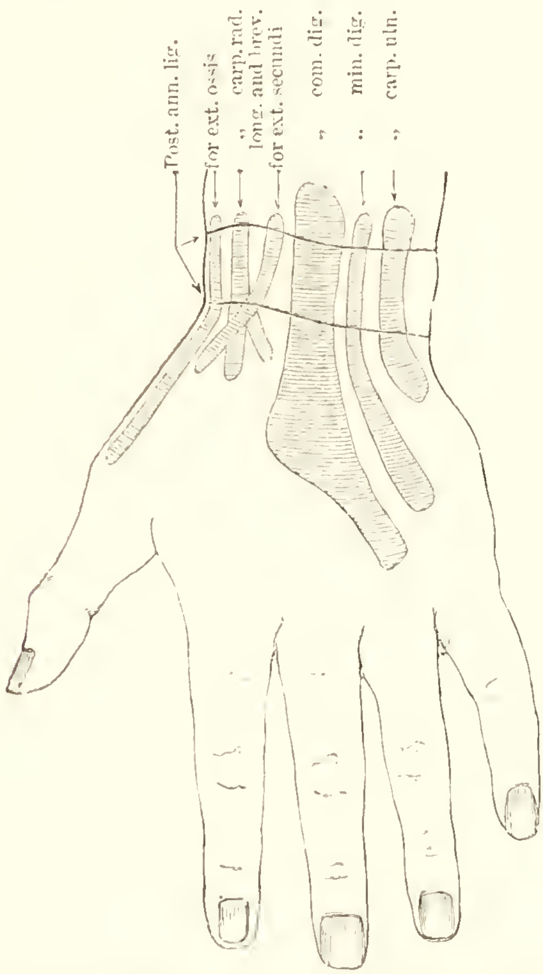


FIG. 126.—DIAGRAM OF THE SYNOVIAL SHEATHS OF THE EXTENSOR TENDONS OF THE LEFT HAND AND THE MARKINGS ON THE DORSUM OF THE FINGERS.

triceps; and, *deeply*, are the elbow joint, the orbicular ligament, the recurrent interosseous vessels, the ulna, and a small part of the supinator brevis.

Action.—Its *transverse* fibres assist the triceps in extending the elbow, but its *oblique* ones may possibly help in flexing the elbow.

Nerve.—Posterior interosseus.

Dissection.—Divide the extensors communis, minimi digiti, and carpi ulnaris just below their origins, and reflect them, and observe the branches of the posterior interosseous artery and nerve going to these muscles. The transverse intermuscular septum separating the superficial and deep muscles

must also be removed with care, and the muscles, vessels, and nerves freed from any loose fat and cellular tissue. The muscles must be carefully separated, and a slender portion of the posterior interosseous nerve, which is beneath the extensor secundi internodii, about the middle of the forearm, must not be injured.

Deep Muscular Layer.—There are five small muscles in this layer; three are special extensors of the thumb, and one of the forefinger, and there is one supinator of the forearm, the supinator brevis, which surrounds the upper part of the radius; and below this are the three thumb muscles in the following order from above downwards: first, the extensor ossis

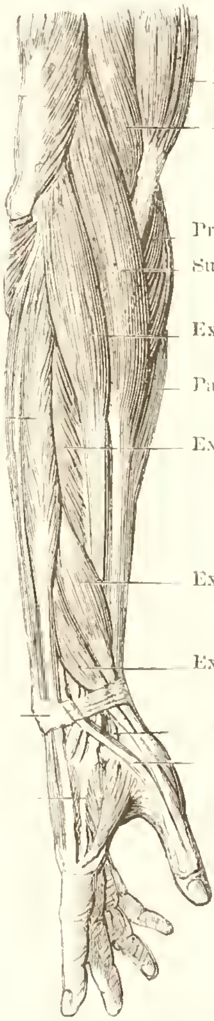


FIG. 127.—RIGHT FOREARM MUSCLES. OUTER ASPECT.

metacarpi pollicis; then the extensor primi internodii; and then the secundi internodii. The extensor indicis is on the back of the ulna.

The **Extensor Ossis Metacarpi Pollicis** (*Abductor Longus Pollicis*) is the largest, highest, and most external of the thumb extensors. It is immediately below the supinator brevis, with which it is sometimes blended. It *arises* from an elongated depression on the radial side of the posterior surface of the shaft of the ulna, below the origin of the supinator brevis and the insertion of the anconeus, from the back of the interosseous liga-

ment, and from the middle third of the posterior surface of the radial shaft. This attachment is lower than that from the ulna. Its tendon passes obliquely down and out with that of the extensor primi internodii, in a groove on the outer side of the styloid process of the radius, and is *inserted* mainly into the outer side of the base of the metacarpal bone of the thumb, and by a slip into the outer side and dorsum of the trapezium.

Relations.—Superficially, with the deep fascia, the common tendon of

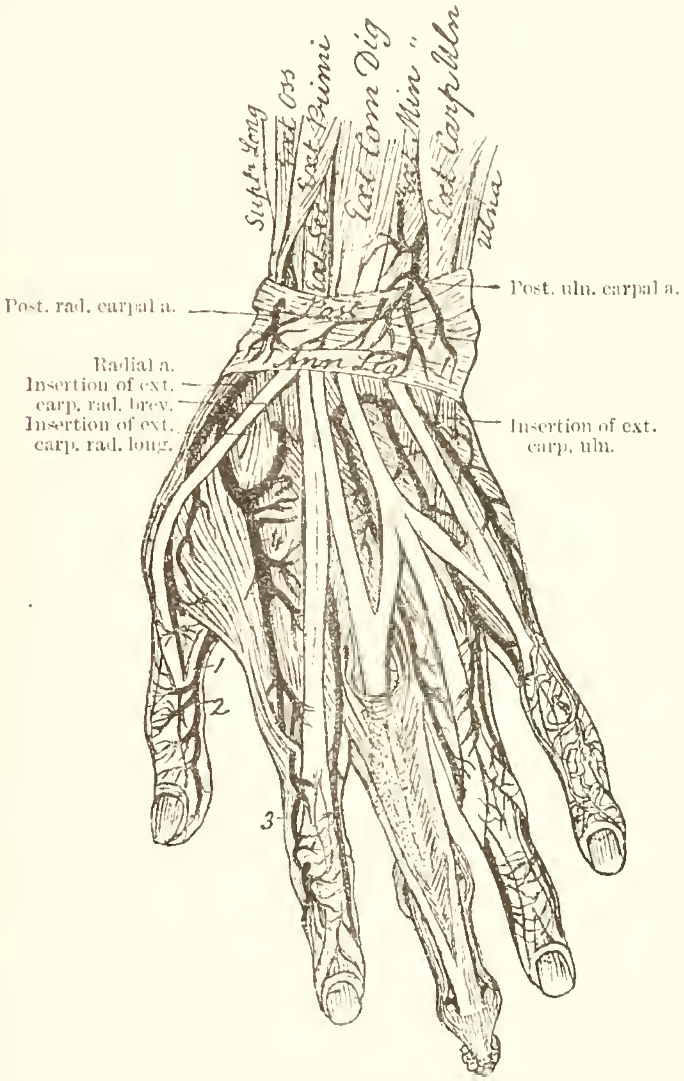


FIG. 128.—TENDONS AND ARTERIES AT BACK OF LEFT HAND.

1. Tendon of flex. long. poll. 2. Princeps pollicis a. 3. Radialis indicis. 4 4. Metacarpal arteries. The carpal arch is shown. The dorsal digital veins are shown on the little finger, and on the middle the expansions from interossei and lumbricales.

origin of the extensors and the branches of the posterior interosseous artery and nerve, which cross it; *deeply*, with the ulna, radius interosseous membrane, and the tendons of the extensors carpi longior and brevior, which it obliquely crosses, and at the *outer side* of the wrist it crosses the radial artery. Between its *upper border* and the supinator brevis is the posterior interosseous artery, and its *lower border* is in relation with the extensor primi internodii.

Action.—It moves the thumb back from the palm by extending its metacarpal bone. It can then extend the wrist on the radial side. This and the other two extensors of the thumb can, when the thumb has been drawn in towards the palm, assist in supinating the forearm in consequence of the oblique direction of their tendons.

Nerve.—Posterior interosseous.

Varieties.—This muscle is subject to much variation, which consists in the splitting up of it or its tendon into separate parts. It may be inserted either doubly into the first metacarpal bone or partly into the trapezium, or into the abductor or opponens pollicis muscles. Sometimes the extensor primi internodii is fused with it. I have seen it muscular or fleshy at the metacarpal bone of the thumb.

The **Extensor Primi Internodii Pollicis** is the smallest muscle of this set. It *arises* from the posterior surface of the shaft of the radius for about an inch, and from a corresponding portion of the back of the interosseous membrane. Its fibres end in a tendon which passes through the same groove on the outer side of the styloid process of the radius with the preceding muscle, and is *inserted* into the base of the first phalanx of the thumb on its dorsal aspect.

Relations.—It lies between the extensor ossis on the *outer* and the extensor secundi on the *inner* side. In *front* is the interosseous membrane, and *behind* is the deep fascia. Its tendon crosses the radial artery at the wrist, also its dorsalis and princeps pollicis branches. The posterior cutaneous branches of the radial nerve cross the extensors of the thumb and index finger. The end of the posterior interosseous artery and the posterior or perforating branch of the anterior are in *anterior* relation with this and the two following muscles.

Action.—It extends the proximal phalanx of the thumb, and then the wrist joint.

Varieties.—This muscle is sometimes absent, being fused with the extensor ossis metacarpi. In other instances it is more or less joined with the extensor secundi internodii. A common variety is the interposition of an additional extensor between the secundi internodii and the indicis. With the double tendon of insertion into both thumb and index finger, this resembles a muscle which normally is present in the dog and many carnivora (*extensor indico-pollicis*).

Nerve.—Posterior interosseous.

The **Extensor Secundi Internodii Pollicis** is much larger than the primi, and partly covers its origin. It *arises* from the posterior surface of the ulnar shaft for two or three inches below the extensor ossis and anconeus, and from the back of the interosseous membrane below for about an inch. Its tendon occupies a deep oblique narrow groove in the middle and posterior surface of the lower end of the radius, and is contained in a separate partition beneath the posterior annular ligament. It then obliquely crosses the radial extensors of the carpus, being separated by a triangular interval from the other thumb extensors, in which is the radial artery, and is *inserted* into the base of the terminal phalanx of the thumb.

Relations.—*Superficially*, with the same parts as the other thumb extensors, and *deeply*, with the ulnar, radius, interosseous membrane, posterior ligament of wrist, radial vessels, metacarpal bone of thumb, and back of the finger joints.

Action. It extends the second phalanx, and then the metacarpal bone and wrist joint.

Nerve.—The posterior interosseus.

Variety.—It may have the extensor primi internodii more or less united with it.

The **Extensor Indicis**, or **Indicator**, is a long narrow muscle on the inner side of, and parallel with, the preceding. Its origin is from the posterior surface of the ulna for three or four inches, usually below the middle, and internal to the preceding muscles, also from the interosseous membrane. Its tendon accompanies the extensor communis in the same compartment of the annular ligament, and joins on its ulnar side the tendon of the common extensor, which goes to the index finger, opposite the lower end of the corresponding metacarpal bone. It is inserted into the second and third phalanges of the index finger, in the manner mentioned when describing the extensor communis digitorum.

Relations.—In *front* is the interosseous membrane, *behind* is the deep fascia, *inside* is the ulna, and *outside* the extensor secundi internodii. It crosses the radial artery at the outer side of the wrist, also its branches to the thumb.

Nerve.—The posterior interosseous.

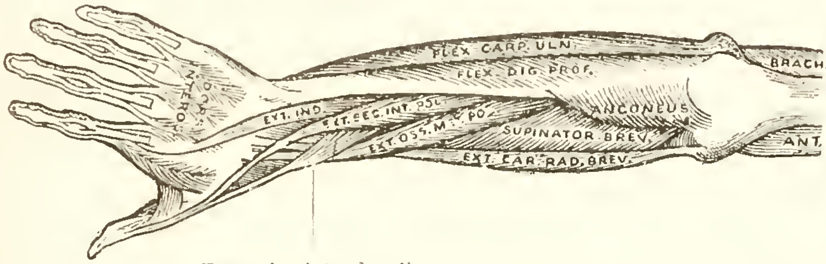


FIG. 129.—THE MUSCLES ON THE BACK AND OUTER SIDE OF THE RIGHT FOREARM.

The insertions of the long and short extensors of the carpus are shown beneath the tendon of the secundi.

Action.—It can extend the forefinger even when the others are bent. It assists the common extensor in drawing the hand backwards.

Varieties.—An extra short extensor is sometimes present. It is most often connected with the index finger, and Albinus named it the *extensor brevis indicis*. Its origin varies much, and may come from the radius or from a carpal or metacarpal bone, and its insertion may be into one or more of the digits, making an *extensor brevis digitorum*.

Dissection.—Detach the anconeus from its origin, and divide and reflect the supinator longus and radial extensors. The supinator brevis will then be exposed and must be cleaned.

The **Supinator Radii Brevis** is a broad, hollow, cylindrical muscle, surrounding the upper third of the radius. It *arises* from the external condyle of the humerus, from the external lateral ligament of the elbow, from the orbicular ligament of the radius, from the ridge on the ulna which passes obliquely down from the back of the lesser sigmoid cavity, from the triangular depression in front of it, and from a tendinous expansion which covers the muscle. The fibres pass obliquely down, the upper forming a sling around the radial neck above the tuberosity, and are attached to the back of its inner surface; the middle fibres are attached to the outer

edge of the tuberosity, and the lower to the oblique line of the radius as low down as the insertion of the pronator teres. It is pierced by the posterior interosseous nerve.

Relations.—*Superficially*, with the supinator longus, superficial extensors and radial vessels and nerves; *deeply*, with the elbow joint, the interosseous membrane and the radius. Its *lower border* is separated from the

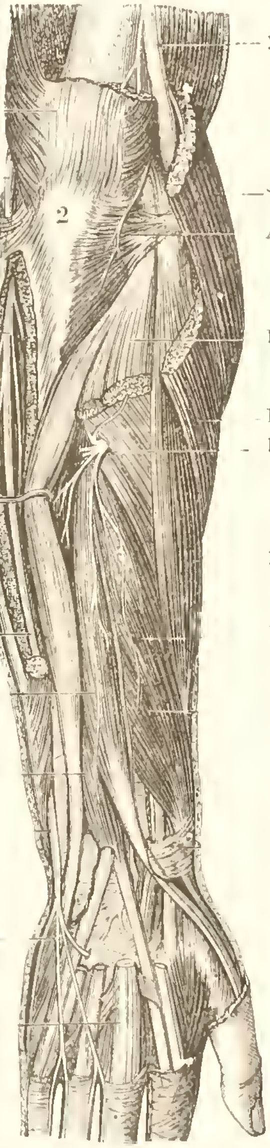


FIG. 130.—DISSECTION OF DEEP MUSCLES AND NERVES AT BACK OF RIGHT FOREARM.

The gangliform enlargement on the posterior interosseous is shown at the back of the wrist.

extensor ossis metacarpi by the posterior interosseous artery. Its *upper border* is in contact with the orbicular ligament.

Action.—If the hand be pronated it will supinate the radius.

Nerve.—The posterior interosseus.

Varieties.—At the place where the posterior interosseous nerve pierces it, it may be more or less divided, and sometimes a slip of it may be inserted into the biceps tendon or radial tuberosity. Cruveilhier and

Gruber have named a short set of fibres between the upper part of the radius and the annular ligament the *tensor ligamenti orbicularis anterior.*

The **Posterior Interosseous Artery** is a branch of the common interosseous from the ulna, and passes backwards through the space between the upper border of the interosseous membrane and the oblique ligament, and passing between the extensor brevis and extensor ossis metacarpi, descends between the superficial and deep muscular layers (giving branches to them) to the lower third of the forearm, where it is more superficial, and lies along the outer side of the tendon of the extensor carpi ulnaris; it then passes to the back of the wrist, where it anastomoses with the anterior interosseous and posterior carpal branches of the radial and ulnar arteries.

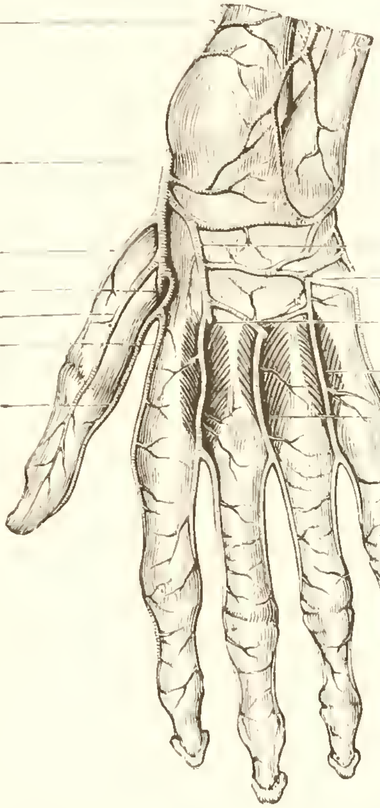


Fig. 131.—Branches of left radial. Posterior view.

The collateral digitals are shown between the fingers.

Near its origin it gives off an *interosseous recurrent* branch. This is usually a large vessel and ascends on or through the supinator brevis, but beneath the anconeus and between the olecranon and external condyle, and anastomoses, after supplying these muscles and the elbow joint, with the posterior articular branch of the superior profunda, the anastomotica magna, recurrent radial and posterior ulnar recurrent.

The **Posterior Interosseous Nerve** is the larger of the terminal branches of the musculo-spiral, is given off in front of the external condyle, and passes through the supinator brevis to the back of the forearm, and emerging from its lower border passes between the superficial and deep muscles to the middle of the forearm, where it is much diminished in size. It then descends on the back of the interosseous membrane beneath

the extensor secundi to the back of the carpus, where *there* is a reddish gangliform enlargement beneath the extensor communis, from which filaments are distributed to the ligaments and articulations of the carpus. It supplies all the muscles of the deep layer and those of the superficial with the exception of the supinator longus, extensor carpi longior, anconeus and sub-anconeus, which are supplied *directly* from the musculo-spiral.

The **Radial Artery at the Back of the Wrist.**—In this situation the artery, with its veins, winds below the radius and across the back of the carpus to enter the palm at the first interosseous space and between the heads of the first dorsal interosseous muscle. It first lies rather deeply on the external lateral ligament of the wrist, being crossed by the extensors of the thumb, but afterwards it is more superficial and is crossed by the extensor secundi. *Superficial* to it in this situation are the skin, subcutaneous veins and some filaments of the radial and external cutaneous nerves. Its *branches* in this situation are small, but numerous. They are the posterior carpal, dorsal interosseous, dorsales pollicis, and dorsalis indicis.

The *Posterior* or *Dorsal Carpal Branch* is given off from the radial beneath the thumb extensors, and crossing the carpus to the inner border of the hand, anastomoses with the posterior carpal of the ulna to form the posterior carpal arch. From this arch branches *ascend* to anastomose with the termination of the anterior interosseous artery and with the posterior interosseus. Others *descend* to the metacarpal spaces, and run along the inner side of the dorsum of the hand and little finger. The vessels which lie between the metacarpal bones are three, and are properly named the *dorsal interosseous arteries*. Those for the third and fourth interosseous spaces run down on the corresponding interossei muscles and divide at the cleft of the fingers into two collateral digital vessels, which run along the contiguous sides of the dorsum of the digits. At the carpal ends of the interosseous spaces they anastomose with the perforating arteries from the deep palmar arch, and near the heads of the metacarpal bones they join the digital branches of the superficial palmar arch.

The *First Dorsal Interosseous* or *Metacarpal* branch arises beneath the thumb extensors, sometimes with the posterior carpal artery, and runs on the second dorsal interosseous muscle, anastomosing *behind* with its corresponding perforating branch from the deep palmar arch, and in *front* with the digital branch of the superficial arch, and supplies the adjoining sides of the index and middle fingers on their dorsum.

The *Dorsales Pollicis* are two small vessels, which arise separately, or by a common trunk, near the base of the metacarpal bone of the thumb and extend along the sides of the dorsal aspect of the thumb, supplying it and anastomosing with its palmar digitals.

The *Dorsalis Indicis* is a small branch along the radial side of the dorsum of the index finger. It gives some twigs to the abductor indicis and anastomoses with the palmar digitals.

Directions.—The posterior interosseous nerve should be dissected out of the supinator brevis, and the attachments of this muscle reflected, so as more thoroughly to understand them and its relations. The different compartments beneath the posterior annular ligament should be opened, and the tendons with their synovial sheaths examined; and when this has been done, the offset from the gangliform enlargement of the posterior

interosseous nerve may be more fully traced. The dorsal interossei muscles should then be cleaned and studied, and the posterior perforating arteries dissected out between their heads of origin, and the anterior perforating defined near their insertions.

There are *six separate partitions* between the posterior annular ligament and the posterior aspect of the lower ends of the radius and ulna. They are from within outwards. 1. A groove for the tendons of the extensor ossis and primi internodii, on the outer side of the styloid process of the radius. 2. Another for the tendons of the extensors carpi radialis longior and brevior, behind the styloid process. 3. A deeper, narrower, oblique groove for the extensor secundi. 4. A groove for the extensors communis and indicis. 5. One for the extensor minimi digiti, which is between the

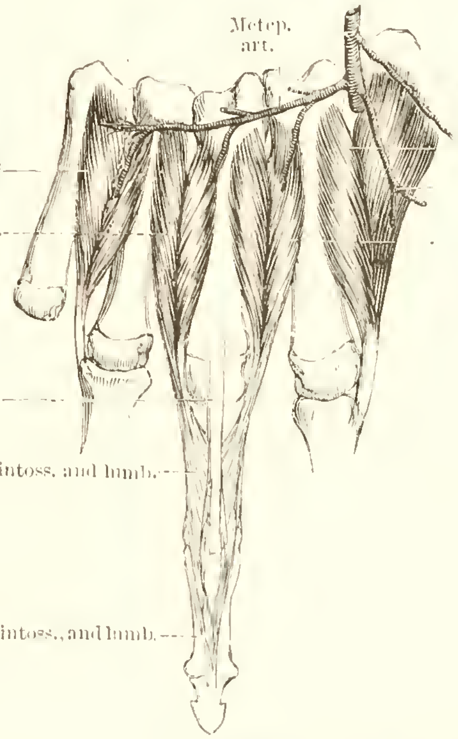


FIG. 132.—RIGHT DORSAL INTEROSSEI AND RADIAL ARTERY.

The metacarpal artery represents the posterior or dorsal arterial arch.

radius and ulna. 6. For the tendon of the extensor carpi ulnaris on the back of the ulna.

The **Dorsal Interossei** muscles are *four* and are larger than the palmar. They are penniform muscles and *arise* by two heads from the adjacent sides of the fifth metacarpal bones, but more extensively from that side of the metacarpal bone which corresponds to the side of their *insertion*, which is into the bases of the first phalanges, and into the expansion of the common extensor tendon. Between the heads of origin of each muscle is a small triangular interval, through which a posterior perforating branch from the deep palmar arch passes to anastomose with the dorsal interossei arteries.

The *First Dorsal Interosseous* or *Abductor Indicis* is larger than the rest. It is flat and triangular, and arises by two heads, separated by a

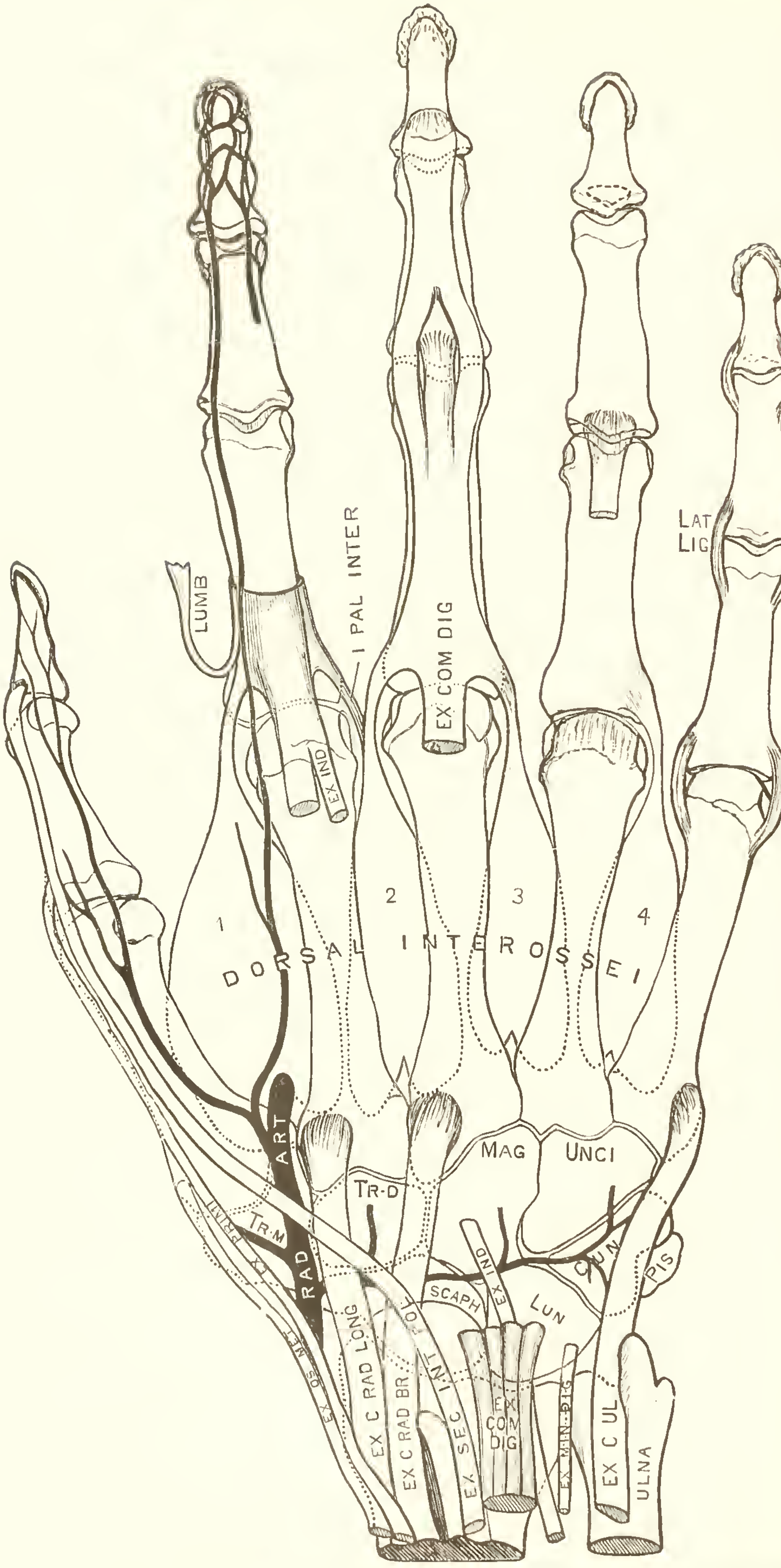


FIG. 133.—DORSAL ASPECT OF RIGHT HAND. OUTLINE DIAGRAM FROM *Cossar Ewart*

slight fibrous arch, through which the radial artery passes from the dorsum to the palm of the hand. Its *outer* head *arises* from the upper half of the ulnar border of the metacarpal bone of the thumb, and its *inner* from

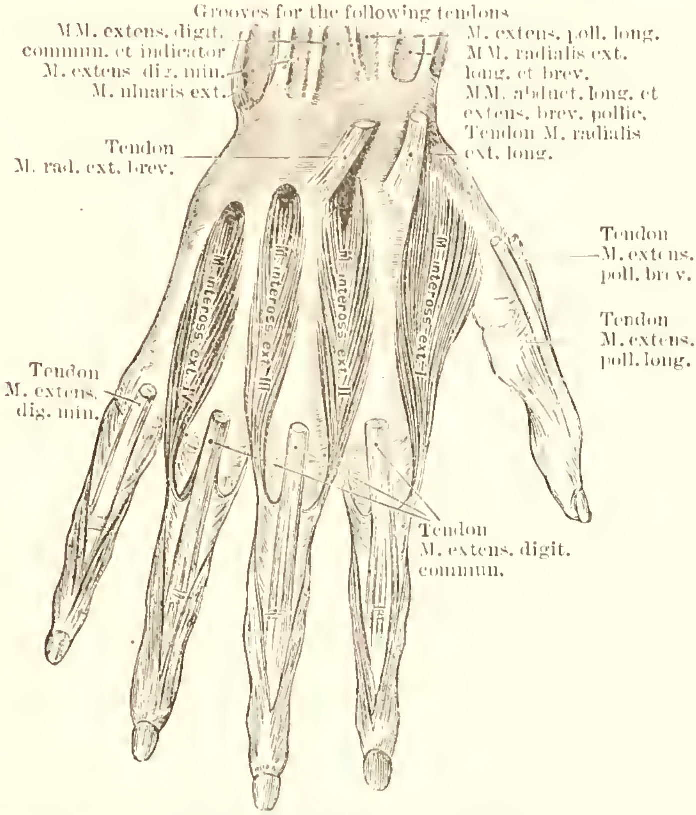


FIG. 134.—DISSECTION TO SHOW THE TENDONS ON THE BACK OF THE HAND AND THE DORSAL INTEROSSEI.

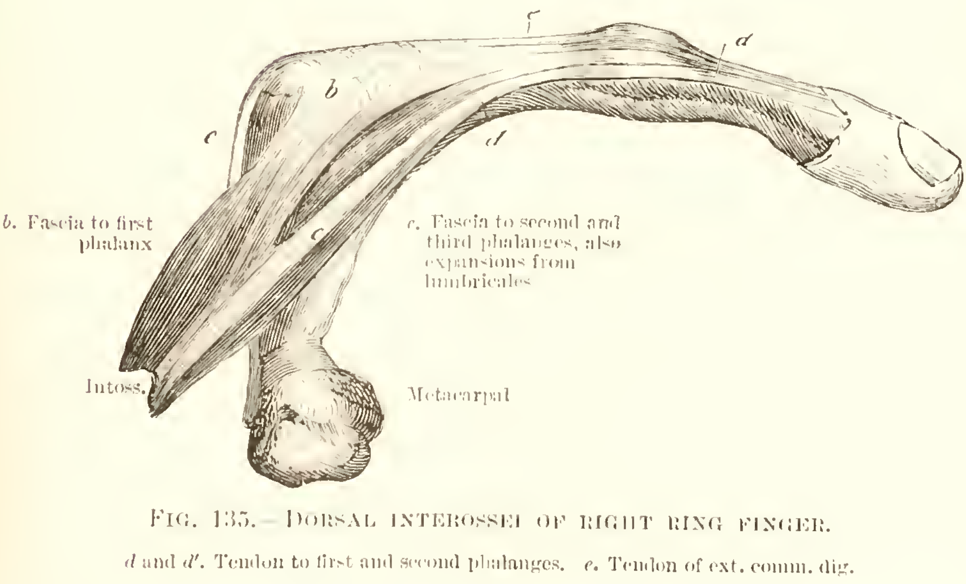


FIG. 135.—DORSAL INTEROSSEI OF RIGHT RING FINGER.

d and *d'*. Tendon to first and second phalanges. *e*. Tendon of ext. comm. dig.

nearly the whole length of the radial border of the second metacarpal. Its tendon is *inserted* into the *radial* side of the base of the first phalanx of the index finger, and by an expansion anterior to its bony insertion into the outer side of the tendon of the common extensor.

The *Second* and *Third Dorsal Interossei* are *inserted*, the former into the *outer* side of the base of the first phalanx of the middle finger, and the latter into its inner side. The fourth muscle is *inserted* into the *inner* side of the base of the first phalanx of the ring. They all have similar tendinous expansions to that of the first muscle. These are connected with the respective outer or inner sides of the corresponding tendon of the common extensor.

Actions.—They are *ab*ductors of the fingers, from a line drawn longitudinally through the centre of the middle finger. They assist the extensors of the digits, but when the fingers are slightly bent they assist in completing this action. John Hunter, and more recently Cleland, have said that these muscles flex the first phalanges and extend the two distal ones, whereas Quain and Thomson say that the interossei, assisted by the lumbricales, flex the first phalanges, and at the same time, by their union with the common extensor tendon, extend the other phalanges. Duchenne states that the interossei extend the second and third phalanges, and partly flex the first. He also thinks that the extensor communis acts almost entirely on the first phalanges. The student will note that the thumb and little finger have no dorsal interosseous muscle having *special abductors*, and not therefore requiring an interosseous abductor.

Variations.—The Interossei are sometimes double in one or more of the spaces.

THE FRONT OF THE FOREARM.

Dissection.—Place the limb with the palm uppermost, and make an incision along the middle of the front of the forearm to just beyond the wrist, and at the lower end of this incision make a transverse one, and reflect the skin inwards and outwards, being careful of the many cutaneous vessels and nerves beneath it. The skin should be reflected from one of the fingers in order to be able to follow the description that will be given of the flexor tendons.

The *superficial fascia* of the forearm is continuous above with that of the arm, and below gets much thinner, and is continuous with that of the hand. Between its layers are the cutaneous vessels and nerves, and superficial lymphatics, and in its meshes there is a varying quantity of fat. It is most distinct opposite the bend of the elbow, where the veins are numerous and large.

Position of the Cutaneous Vessels and Nerves.—Most of these have already been seen in part. The continuation of the internal cutaneous nerve will be found near the anterior ulnar vein on the inner side, and on the outer, accompanying the radial vein, is the superficial part of the musculo-cutaneous nerve. Near the wrist, in the mid-line of the forearm, is the slender palmar cutaneous branch of the median. It is to the inner side of the tendon of the flexor carpi radialis, and the palmar cutaneous branch of the ulna lies over the ulnar artery, close outside the pisiform bone. The ulnar has usually another cutaneous branch, which is given off just above the wrist.

Cutaneous Veins.—The superficial veins in this region are the radial, median and ulnar. They commence chiefly from an arch on the back of the hand, which receives the posterior or superficial digital veins. The

radial and ulnar commence at the outer and inner sides of this arch, but the median is derived from small branches near the wrist on the palmar surface of the hand and lower part of the forearm.

Ulnar Veins.—These are anterior and posterior. The latter has been dissected with the back of the forearm, and traced to its junction with the anterior ulnar to form the basilic.

The *Anterior Ulnar* vein commences on the anterior aspect of the hand and wrist, on its inner side, and ascends along the ulnar portion of the forearm to just below the elbow, where it is joined by the posterior ulnar vein, and forms the basilic. It communicates with the median in front, and the posterior ulnar behind.

The *Radial Vein* arises from small venous radicles on the dorsal surface of the thumb, index finger, and radial side of the hand, by branches communicating with the *vena salvatella.* These unite and form a large vessel (the radial vein), which ascends along the outer side of the forearm, receiving many branches from both its surfaces, to the elbow, where with the median cephalic it forms the cephalic vein.

The *Median Vein* collects the blood from the palmar surface of the hand and middle of the forearm, joining the radial and anterior ulnar veins. Just below the bend of the elbow it receives a communicating branch from the deep veins of the forearm, and divides into an outer or median cephalic, and inner or median basilic, the former uniting with the radial to form the cephalic vein, and the latter with the trunk formed by the union of the anterior and posterior ulnar veins, to form the basilic.

Cutaneous Nerves.—The anterior branch of the external or musculo-cutaneous passes down, usually beneath the median cephalic vein, along the radial border of the forearm to the ball of the thumb. It communicates with the anterior filament of the internal cutaneous and with the palmar cutaneous of the median. It is in front of the radial artery, and some filaments pierce the fascia and accompany the radial to the back of the wrist, and supply the wrist joint. Just below the middle of the forearm it gives off one or two branches to its posterior aspect, which reach nearly to the wrist, and communicate with the radial and lower external cutaneous branch of the musculo-spiral.

The **Radial Nerve** runs along the front of the outer side of the forearm to the junction of its middle and lower third. It is at first rather to the outer side of the radial artery, and about three inches above the wrist pierces the deep fascia at the outer border of the forearm, and divides into two branches, outer and inner. These supply the back of the radial side of the hand and fingers, and have been dissected with that region.

The *Anterior Branch of the Internal Cutaneous Nerve* passes partly in front and partly behind the median basilic vein on the anterior surface of the ulnar side of the forearm, supplying the skin as far as the wrist, and joining a cutaneous branch from the ulnar and the external cutaneous.

The *Superficial Cutaneous Branch of the Ulnar* pierces the deep fascia near the wrist and communicates with the preceding.

Directions.—After cleaning these structures and tracing them to where they pierce the deep fascia, the student, having studied the anterior annular ligament, must reflect the deep fascia by incisions similar to those through which he reflected the skin, and must study its various processes and attachments. The anterior annular ligament has to be left for the

present, but the cutaneous vessels and nerves, with the exception of the palmar cutaneous branches of the median and ulnar, are to be reflected. At the upper part of the forearm the deep fascia will be found intimately blended with the muscles which arise from its under-surface.

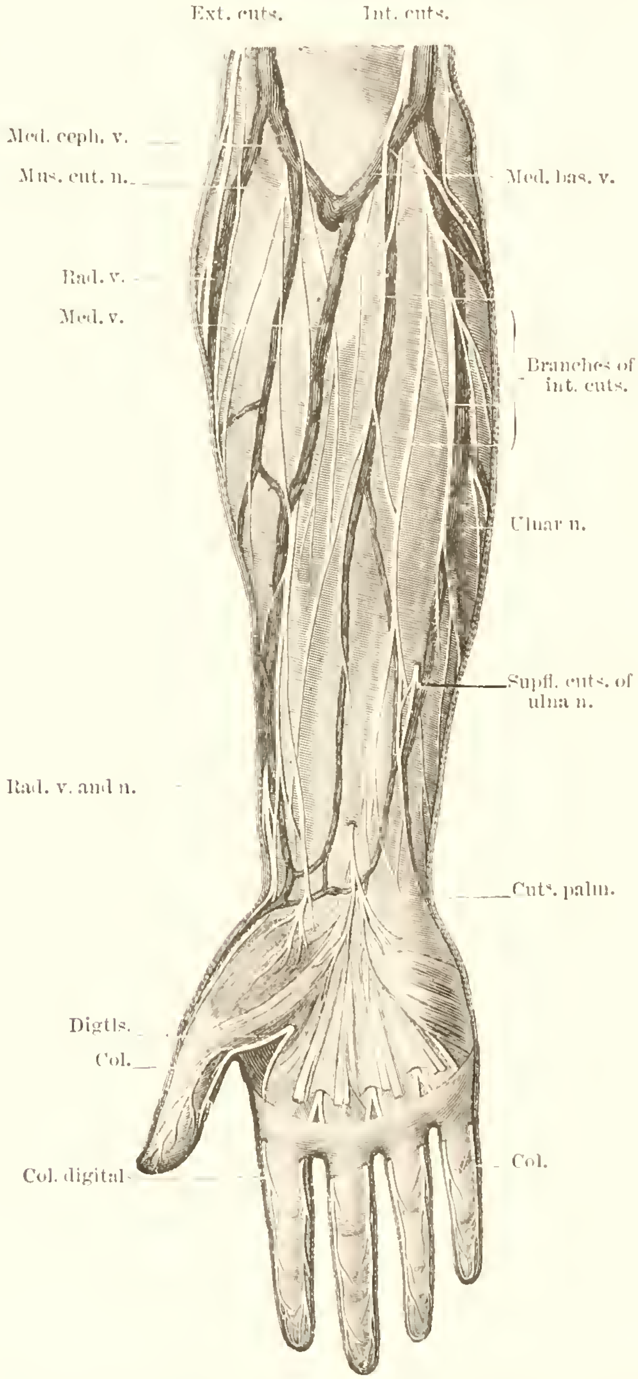


FIG. 136.—CUTANEOUS NERVES AND VEINS OF FRONT OF RIGHT ARM.

The median vein is seen piercing the deep fascia, and the bifurcation of the digital nerves is dissected out below the palmar fascia.

The *Aponeurosis* or *Deep Fascia* of the forearm is a strong glistening membranous investment, which forms a general sheath for the muscles of this region, and from its deep surface gives off intermuscular septa, which

separate and enclose the various muscles. Like that of the arm, it is composed principally of circular fibres strengthened by longitudinal and oblique ones, which descend from the humeral condyles, from the olecranon, and from the semilunar or bicipital fascia.

The anterior part of this aponeurosis (the part now being dissected) is much weaker than the posterior, and is continued below into the anterior annular ligament of the wrist. Near the elbow it is stronger than in the middle of the forearm, and receives fibrous expansions from the biceps and brachialis anticus. In the hollow just below the elbow-bend there is a small oval aperture, which transmits a short communicating branch between the superficial and deep veins of the forearm. A little above the wrist it forms a sheath for the tendon of the palmaris longus, which pierces it, passing over the annular ligament to the palmar fascia. Longitudinal white lines indicate the position of the intermuscular septa, and separating the superficial from the deep flexors is a horizontal process which is given off from this fascia: this is stronger below than above, where it usually consists of thin connective tissue. It is pierced close to the outer side of the pisiform bone by the ulnar vessels and nerve.

The *Anterior Annular Ligament* is a deep thickened portion of this deep fascia, in front of the wrist. It is a strong fibrous band arching over the front of the carpus, and completing the deep groove on the front of the carpal bones into a canal, beneath which the flexor tendons pass. Its attachments will be subsequently dissected. Its upper margin is continuous with the deep fascia of the forearm, and receives fibres from the tendon of the flexor carpi ulnaris; and its lower margin is connected with the palmar fascia.

Position of Parts.—In front of the elbow is a depression which has already been partly dissected. In this space, from within outwards, the student must define the ulnar recurrent artery, median nerve, the brachial artery giving off the radial and ulnar, the tendon of the biceps, and the musculo-spiral nerve. On the outer side will be found the supinator longus, and in the lower half of the forearm, between it and the flexor carpi radialis, is the radial artery. On the inner side will be found the superficial flexors and pronators, and at the lower part of the forearm, between the flexor carpi ulnaris and the flexor sublimis digitorum, will be seen the ulnar artery and nerve. These pass over the anterior annular ligament.

Hollow in Front of the Elbow. Boundaries.—This space corresponds to the popliteal hollow at the back of the knee. It is a triangular interval with the *base* above, which corresponds to a transverse line just above the condyles. Its *outer* side is formed by the supinator longus, and its *inner* by the pronator radii teres. It is covered in by the skin and superficial and deep fasciæ, and its floor is formed by parts of the brachialis anticus and supinator brevis.

Contents.—This hollow contains the brachial artery and its venæ comites, and radial and ulnar branches, the median and musculo-spiral nerves, recurrent radial and anterior ulnar recurrent arteries, the tendon of the biceps, some fat, and one or two lymphatic glands.

Position of Parts.—In the midline is the brachial artery, which divides opposite the coronoid process of the ulna into the radial and ulnar. The median nerve is on the inner side of the artery, but distant from it *below* about half an inch. The biceps tendon is on the outer side going

to the radius; and still more external, lying upon the supinator brevis, and partly concealed by the supinator longus, is the musculo-spiral nerve. The radial recurrent artery is near the musculo-spiral on the outer side, and the anterior ulnar recurrent is internal to the median nerve. The lymphatic glands lie on the sides of the brachial artery, and one just below its bifurcation between the radial and ulnar.

Muscles on the Front of the Forearm.—These are divided into a superficial and deep layer. There are five in the superficial layer which arise from the inner humeral condyle mostly by a common tendon. They

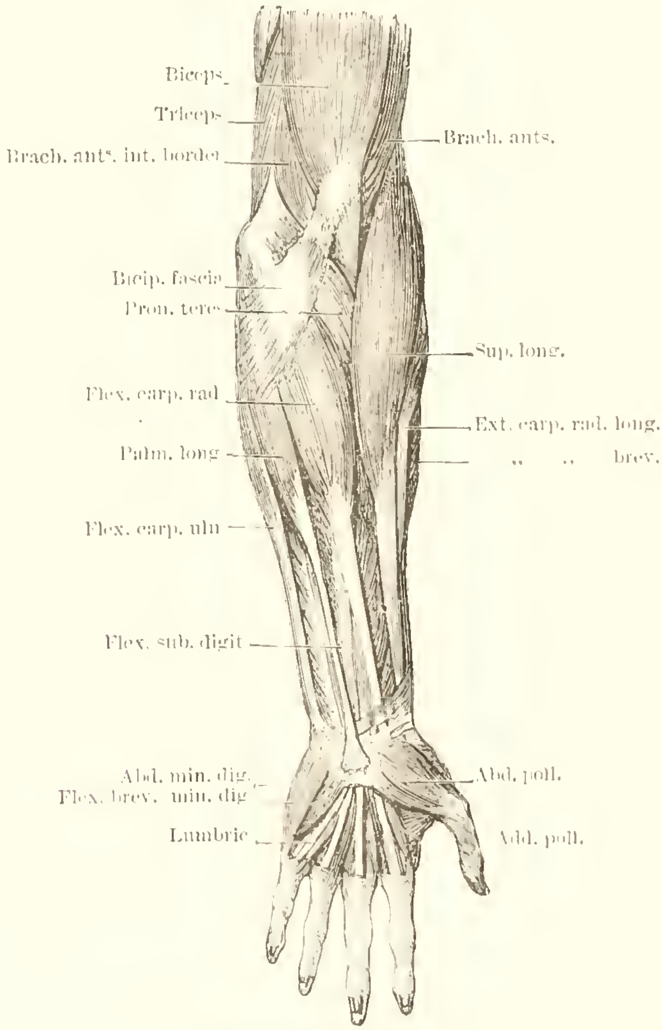


FIG. 137.—SUPERFICIAL MUSCLES OF THE FRONT OF THE LEFT FOREARM.

are the *superficial flexors and pronators*, and from within outwards are the pronator teres, flexor carpi radialis, palmaris longus, flexor carpi ulnaris; and deeper and bigger than any of these is the flexor sublimis digitorum. These are the superficial muscles of the *anterior brachial region*.

The **Pronator Radii Teres** is the most *external* of the group, and *arises* by two heads. The larger and more superficial comes from the upper part of the inner condyle, from the common tendon, intermuscular septum, and deep fascia. The second head is a thin fasciculus, deeply placed,

and arises from the inner margin of the coronoid process of the ulna, below the coronoid origin of the flexor sublimis digitorum, and joins the larger slip at an acute angle. Between these two slips the median nerve enters the forearm. The fleshy belly formed by the union of the heads passes obliquely down and out across the forearm, and ends in a flat tendon which turns over the outer margin of the radius, and is *inserted* into a rough surface, an inch in length, at the middle of the outer surface of the radial shaft.

Relations.—*Anteriorly* are the deep fascia, the supinator longus, and the radial vessels and nerve; *posteriorly* are the brachialis anticus, flexor sublimis digitorum, the ulnar artery and median nerve; the small head of origin of the muscle being placed between the vessel and nerve. Its *inner border* is in contact with the flexor carpi radialis, and its *outer border* forms the inner boundary of the triangular hollow at the elbow-bend, and is in close relation with the median nerve.

Actions.—It assists in bringing the radius forwards over the ulna, and thus pronating the hand; but if the radius be fixed, it brings that bone towards the humerus and flexes the elbow. In climbing it may assist to bring the humerus towards the forearm, thus helping to raise the body.

Nerve.—The median.

Varieties.—Its coronoid head may be absent, or it may very rarely exist as a separate muscle, inserted into the front of the radius higher up than the rest of the usual muscle. Sometimes a slip arises from the intermuscular septum above the inner condyle, or from the supra-condyloid process when that is present; and this peculiarity may be associated with the deviation of the brachial artery, accompanied by the median nerve beneath the bony process. It may have a third head of origin from the biceps or from the brachialis anticus. The coronoid head may, instead of joining the other head of the pronator teres, be connected with the flexor carpi radialis or palmaris longus.

The **Flexor Carpi Radialis** *arises* from the inner condyle by the common tendon, from the intermuscular septa and from the deep fascia. It is aponeurotic and slender at its commencement, but increases as it descends, and ends about the middle of the forearm in a flat tendon, which forms the lower two-thirds of the muscle. This passes beneath the anterior annular ligament in a special compartment at its outer side, runs through a groove on the palmar aspect of the trapezium (which is converted into a canal by a fibrous sheath and lined by a synovial membrane), and is *inserted* into the base of the metacarpal bone of the index finger on its palmar and outer aspects, and frequently by a slip into the metacarpal bone of the middle finger.

Relations.—*Superficially*, with the skin and deep fascia; *deeply*, with the flexors sublimis and longus pollicis and wrist joint. Its *inner border* is in relation with the palmaris longus *above*, and the median nerve *below*, and its *outer border* with the pronator radii teres *above*, and radial vessels *below*.

Action.—It flexes the wrist on the radial side and inclines the hand outwards, and continuing to contract it flexes the elbow. It may assist the pronator teres in climbing.

Nerve.—The median.

Varieties.—It may be absent in one or both arms, or there may be an extra muscle, named by Wood the *Flexor Carpi radialis brevis* or *profundus*. This is present about six times in seventy subjects. It is placed beneath the flexor carpi radialis, and arises usually from the outer side of the radius above the pronator quadratus, and below the flexor pollicis, and is inserted into the base of the middle metacarpal bone and os magnum, but many varieties have been described both with respect to its origin and insertion. Its origin may be connected by an additional slip with the coronoid process of the ulna, or with the tendon of the biceps or semilunar fascia, and its insertion may be into the trapezium, or into the third or fourth metacarpal bone, as well as into the second. The coronoid slip of the pronator teres may be connected with it.

The **Palmaris Longus**, the smallest muscle of this group, is a slender fusiform muscle *arising* from the inner condyle by the common tendon and from the intermuscular septa, and ends in a long slender flattened tendon, which is *inserted* into the palmar fascia near the middle of the wrist, and sometimes joins the short muscles of the thumb by a tendinous slip. Its tendon pierces the deep fascia of the forearm, and passes over the anterior annular ligament, to which it is connected.

Relations.—Superficially, with the deep fascia; *internally*, with the flexor carpi ulnaris, and the median nerve is close to the inner and posterior side of the tendon just above the wrist; *externally*, with the flexor carpi radialis.

Action.—It is a tensor of the palmar fascia, and can also flex the wrist and elbow, assisting the other muscles having similar actions.

Nerve.—The median.

Varieties.—It is a very variable muscle, and is absent in about ten per cent. of subjects. Its fleshy belly is sometimes very long, or it may occupy the middle of the muscle, its extremity being tendinous, or it may be muscular at its lower end, its upper portion being tendinous. Occasionally there is a second palmaris longus placed on the inner side of the preceding, one muscle having the ordinary shape, while the other has one of the forms just described. The second palmaris ends below usually in the annular ligament, deep fascia, or partly in the small muscles of the little finger. The origin of the ordinary palmaris may pass up to the triceps muscle.

The **Flexor Carpi Ulnaris.**—The *innermost* muscle of this group *arises* by two heads connected by a tendinous arch, between which the ulnar nerve passes down and the posterior ulnar recurrent artery runs up. One head *arises* from the inner condyle of the humerus by the common tendon; the other from the inner margin of the olecranon and by an aponeurosis from the upper two-thirds of the posterior border of the ulna (this aponeurosis is intimately connected with the deep fascia of the limb), and from the intermuscular septum. The fibres end in a shortish tendon on the anterior part of the lower half of the muscle, and is *inserted* into the pisiform bone, and is prolonged by tendinous or ligamentous bands to the anterior annular ligament, to the base of the fifth metacarpal and unciform bones, and to the muscles of the little finger. There is sometimes a small bursa between it and the pisiform.

Relations.—Superficially, with the deep fascia, with which it is closely connected; *deeply*, with the flexor sublimis and profundus, the pronator

quadratus, and the ulnar vessels and nerve. Its *outer* or radial border is in relation above with the palmaris longus, and in its lower two-thirds with the ulnar vessels and nerve. Its tendon *pierces* the anterior annular ligament.

Actions.—It flexes the wrist on its ulnar side, and draws the hand inwards, it then bends the elbow joint. Acting from below, it assists the previous muscles in climbing.

Groove.—The ulnar.

Varieties.—Sometimes there is a supernumary muscle passing from the inferior fourth of the anterior surface of the ulna to the unciform, and occasionally some muscular fibres pass transversely from the internal condyle to the ulna just above the ulnar nerve. At times its tendon gives fibres to the anterior annular ligament.

The **Radial Artery** is one of the two terminal branches into which the brachial divides. It appears from its direction to be the continuation of the brachial, though it is not so large as the ulnar. It passes along the front of the outer side of the forearm to the lower end of the radius, below which it winds round the outer border of the wrist, and at the back of the space between the metacarpals of the thumb and forefinger passes forwards into the palm of the hand and crosses to its inner side to join the deep branch of the ulnar artery and form the *deep palmar arch.*

In the forearm it extends from opposite the radial neck to the anterior part of the styloid process, being to the inner side of the radial shaft above, and in front of it below. A line drawn from the centre of the elbow to the fore part of the radial styloid process will indicate its position.

It is more superficial than the ulnar, and its upper part is rather deeper than its lower. In *front* of it are the skin, superficial and deep fasciæ, and it is slightly overlapped above by the supinator longus. *Behind* it are the tendon of the biceps, the supinator brevis, and pronator radii teres, the radial head of the flexor sublimis, the flexor longus pollicis, the pronator quadratus, and the lower end of the radius. It is between the supinator longus and the pronator teres in its upper third, and in its lower between the tendons of the flexor carpi radialis and supinator longus. Accompanying veins lie on its sides and join by branches over the artery. The radial nerve runs along the *outer* side of the vessel in the middle third of its course, and some twigs of the musculo-cutaneous nerve cross along the lower part of the vessel as it winds round the wrist. It is separated from the supinator brevis by some fatty tissue. The pulse is usually taken at the lower part of the radial artery just above the wrist.

Branches.—In the forearm the radial gives off the following branches: the radial recurrent, superficialis volæ, anterior carpal, and several muscular.

The *Radial Recurrent* varies much in size, and is the first branch, being given off immediately below the elbow. It passes transversely outwards, and then upwards between the branches of the musculo-spiral nerve, resting on the supinator brevis, and is then between the supinator longus and brachialis anticus. It supplies the upper part of the muscles at the outer side of the limb, and anastomoses in front of the outer condyle with the terminal branches of the superior profunda artery. A branch of moderate size is given off from the lower side of this artery to anastomose with the posterior interosseous recurrent.

The *Muscular* branches supply the muscles on the radial side of the forearm.

The *Superficialis Volæ* is given off usually just where the radial is about to wind round the wrist. It is variable in size, in its place of origin, and in most instances ends in the muscles of the thumb, but in others it is larger, and passes between the thumb muscles, supplying them, and anas-

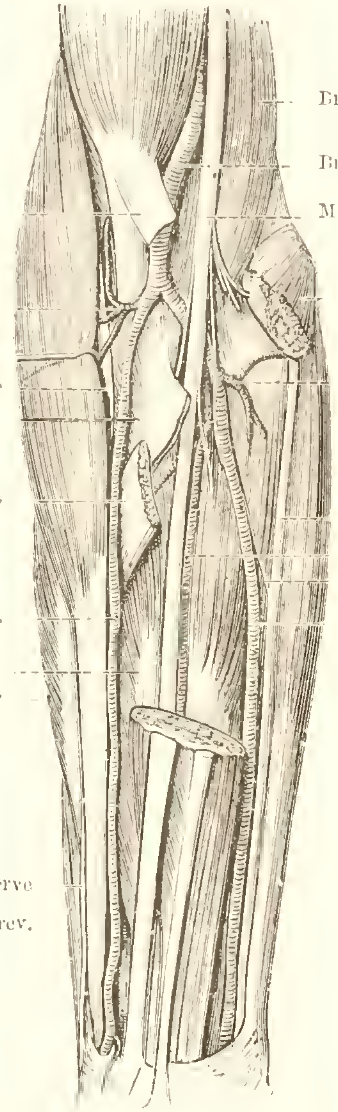


FIG. 138.—VESSELS AND DEEP MUSCLES OF THE RIGHT FOREARM.

The flex. carpi rad. and palm. long. rest on the cut flex. sub. digit.

tomoses with the end of the ulnar artery completing the superficial palmar arch. It may be as large as the continuation of the radial.

The *Anterior Carpal* is small and is given off near the lower border of the pronator quadratus, and runs inwards in front of the radius. It joins the anterior carpal from the ulnar, and forms an arch in front of and above the radio-carpal articulation, from which branches descend and supply the wrist joint.

Varieties of the Radial Artery.—This vessel is less subject to variation than the ulnar, but may deviate as to its origin, course, or branches. Its origin varies in the proportion of about one to eight cases. It more commonly is given off high up, but very rarely lower than usual. The upper part of the brachial is a more frequent source of origin than the

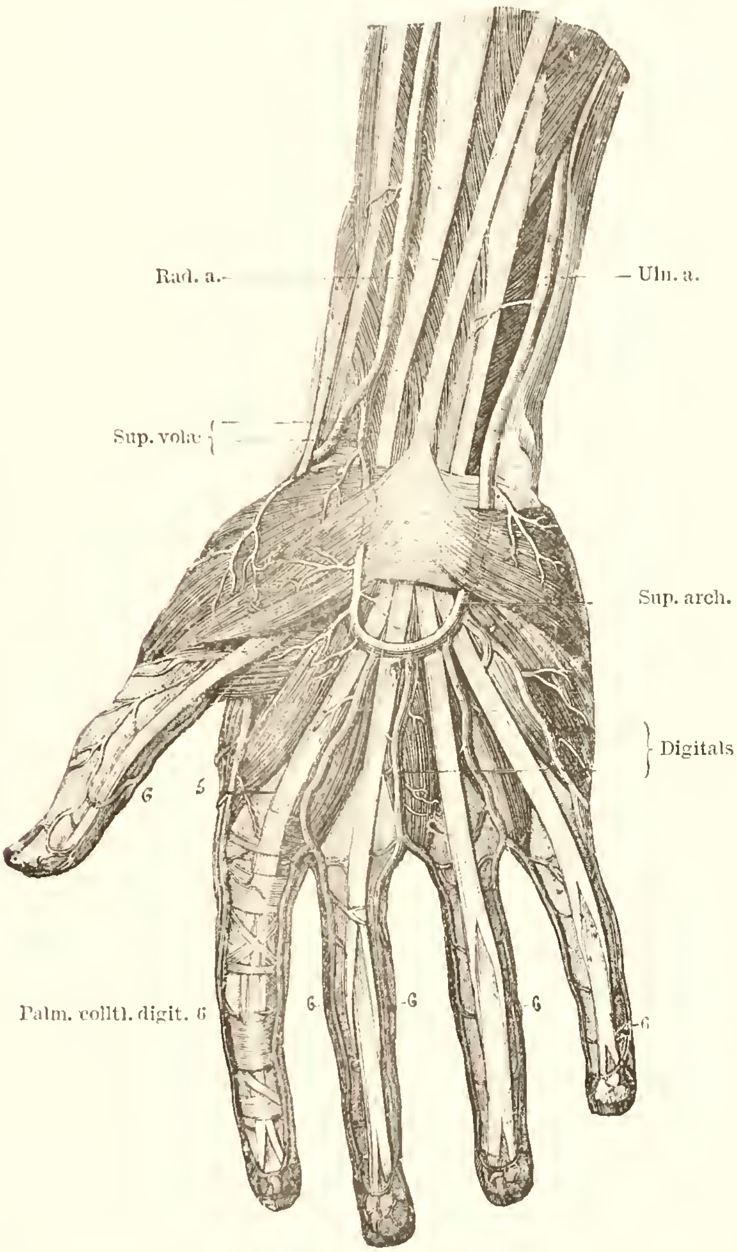


FIG. 139.—RIGHT SUPERFICIAL PALMAR ARCH AND LOWER PARTS OF RADIAL AND ULNAR ARTERIES.

5 indicates the digitals before bifurcation into the collateral digitals, and 6 points to the latter. The tendon of the flex. long. poll. is shown on the thumb, the transverse and X-shaped bands of the tendinous sheaths are shown on the index and the tendons of the flexors sub. and prof. on the other digits.

axillary. It deviates less frequently than the ulnar, but has been found lying over the deep fascia instead of beneath it, or on the surface of the supinator longus instead of near its inner border, and as it turns to the back of the wrist it has been seen to pass over instead of under the

extensor tendons. When there are vasa aberrantia from the brachial or axillary arteries they commonly end in the radial or one of its branches. Other peculiarities of the radial have been given in describing the anomalies of the axillary and brachial arteries.

Peculiarities of the Branches.—The *radial recurrent* may be very large, or represented by several small branches. If the radial itself be given off from the brachial, its recurrent branch has been seen passing beneath the biceps tendon, and in other cases of the origin of the radial high up, the recurrent vessel comes from the brachial trunk, or from the ulna; and more rarely from the interosseous.

FIG. 110. DEEP MUSCLES OF FOREARM. RIGHT SIDE.

The *Superficial Volar* is often very small, and ends in the thumb muscles without joining the palmar arch or any of the digital arches. In cases where it is enlarged it gives one or two digital branches and may or may not anastomose with the superficial arch. It may arise from the radial an inch and a half higher than usual. The radial very frequently gives off a communicating branch to the superficial arch near the lower border of the abductor pollicis.

The *Carpal* and *Interosseous* or *Metacarpal* branches of the radial

may be small, and their place be supplied by the perforating branch of the anterior interosseous.

The *first Dorsal Interosseous* or *Metacarpal* is often large enough to furnish the collateral digital between the index and middle fingers.

Dissection.—Divide the flexor carpi radialis and palmaris longus near

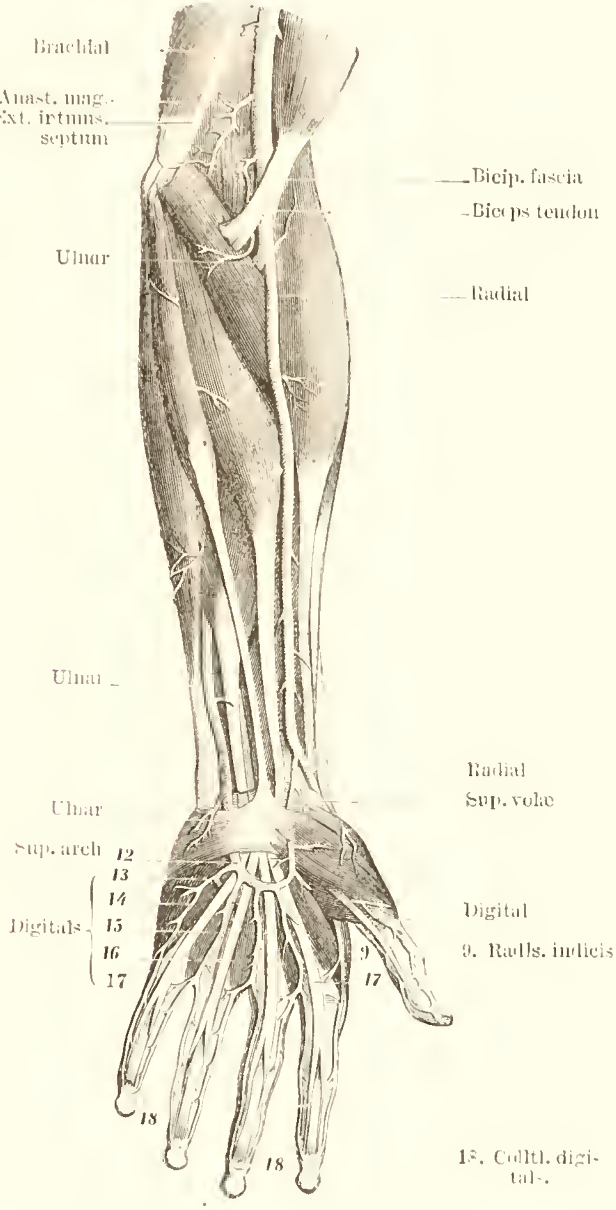


FIG. 141.—ARTERIES OF LEFT FOREARM AND HAND. SUPERFICIAL DISSECTION.

9, 17, 18. Digital and collaterals. Muscular and cutaneous branches are given off in the course of the vessels, and the relations of the tendons to the arteries are shown at the wrist.

their origins and reflect them, noticing small branches of the median nerve and ulnar artery entering their under-surface.

The **Flexor Sublimis Digitorum** or **Perforatus** is the largest of the superficial layer. It is broad and flat, and arises by three heads. One head comes from the internal humeral condyle by the common tendon, from the internal lateral ligament of the elbow, and from the intermuscular

septum. The second head arises from the inner side of the coronoid process of the ulnar, above the ulnar origin of the pronator teres. The third head takes origin by a thin flat portion from the oblique line of the radius and from the anterior border, extending from the tubercle to the insertion of the pronator teres. The fibres pass down vertically and divide about the middle of the forearm into four tendons, which pass beneath the anterior annular ligament in pairs, the *anterior* pair consisting of the tendons for the middle and ring fingers, and the *posterior* of those for the index and middle fingers. The tendon for the little finger is smaller than the rest. It is inserted into the sides of the second phalanges after piercing the profundus digitorum ; its arrangement will be completed in the dissection of the hand.

Relations.—In the forearm, *superficially*, with the superficial muscles and deep fascia ; *posteriorly*, with the flexor profundus, flexor longus pollicis, median nerve and ulnar vessels and nerve. It is crossed near its radial origin by the radial artery.

Actions.—It bends the second phalanges and can then bring the first phalanges towards the palm, as it is bound to them by the flexor sheaths. It can also flex the wrist and elbow joints.

Nerve.—The median.

Varieties.—Its radial origin is occasionally absent, and the body of the muscle may be subdivided so that there is a distinct fleshy belly for each tendon. This occurs most frequently with the portion on the radial and little finger sides. The little finger tendon may be absent, and there may be a small extra tendon to the index finger. It may be connected to the flexor profundus or flexor longus pollicis by a muscular slip. An additional small muscle, the *radio-carpalis*, arising from the outer border of the radius, generally above the pronator quadratus, and being inserted variably into the trapezium, os magnum, or some other carpal bone, or into one of the metacarpals, has been observed.

The **Ulnar Artery** is the larger of the two branches of the brachial, and passes along the front of the inner side of the forearm, across the anterior annular ligament on the outer side of the pisiform bone, into the palm, and forms the *superficial palmar arch*, being sometimes joined by a branch from the radial. It crosses obliquely inwards and is deep at the upper part, but superficial in its lower half.

Relations in the Forearm.—It is deep in its upper half, and describes a slight curve, the convexity of which is directed outwards. In *front* of it are the superficial flexors, excepting the carpi ulnaris. It is crossed by the median nerve, and in its outer half has only the superficial and deep fasciæ in front of it. *Behind* are the brachialis anticus and flexor profundus digitorum. On its *inner* side are the flexor carpi ulnaris, the ulnar nerve in its lower two-thirds, and the median for about an inch near the bend of the elbow. On its *outer* side are the flexor sublimis and the median nerve. Two venæ comites are placed on the sides of the vessel and joined by transverse branches in front and behind it. The ulnar nerve and its palmar branch accompany the vessel over the anterior annular ligament, but the trunk of the nerve is on the inner side and rather posterior to the vessel. A small twig of the ulnar nerve descends on the artery to the palm of the hand, sending filaments around the vessel. It is continued down to the flexor profundus by a thin layer of membrane.

Branches.—In the forearm the ulnar gives off the anterior and posterior recurrents, common interosseous, muscular branches, anterior and posterior carpal, and metacarpal branches.

The *Anterior Ulnar Recurrent Branch* is given off just below the elbow, usually with the posterior recurrent, and passes up and in between the brachialis anticus and pronator teres, supplying them, and anastomoses in

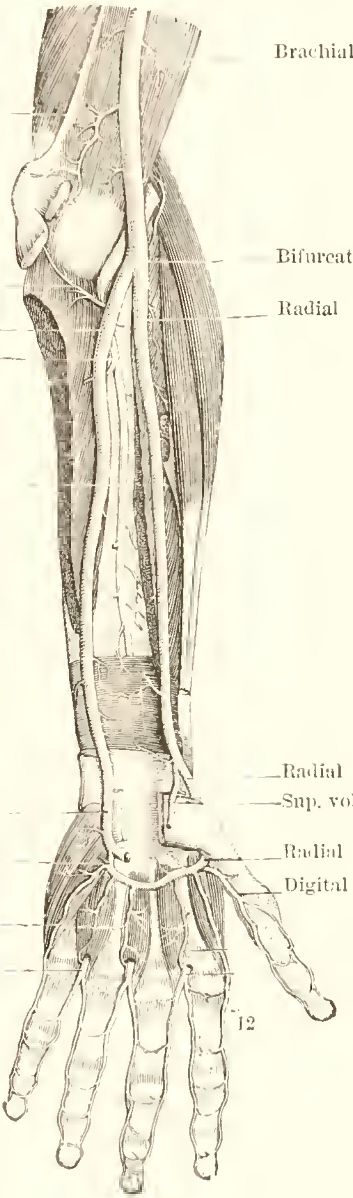


FIG. 142.—ARTERIES OF LEFT FOREARM AND HAND. DEEP DISSECTION.

front of the inner condyle with the inferior profunda and the anastomotica magna.

The *Posterior Ulnar Recurrent* is larger than the anterior, may be given off with the preceding, or may arise somewhat lower down. It passes in and back beneath the flexor sublimis, and ascends in the interval between the inner condyle and olecranon, beneath and between the two heads of the flexor carpi ulnaris. It supplies the joint and parts of the neighbouring

muscles and the nerve itself, and anastomoses with the inferior profunda, anastomotica magna, and over the olecranon, with the posterior interosseous recurrent.

The *common Interosseous* is the largest branch of the ulnar, and is a short thick trunk about an inch long, being given off immediately below the radial tuberosity. It passes to the back of the forearm above the upper border of the interosseous membrane, and divides into an anterior and posterior interosseous branch. These will be subsequently dissected.

Muscular branches from the ulnar supply the muscles along the inner side of the forearm, and some of them pierce the interosseous ligament to supply parts of the extensor muscles.

The *Anterior Carpal* is a very small vessel, which passes across the front of the carpus beneath the flexor profundus, and inosculates with the anterior radial carpal, forming an arch which supplies the carpal bones and articulations, and anastomoses above with the anterior interosseous, and below with the recurrent branches from the deep palmar arch.

The *Metacarpal* artery may be a branch of the posterior carpal, or may be given off from the ulnar near its lower end, arising as a separate vessel.

The *Posterior Carpal* is very small, and is given off just above the pisiform bone, and turns back under the Flex. Carp. Ulnaris along the metacarpal bone to the little finger, being its inner dorsal branch.

Varieties.—This may effect its origin, course, size, and branches.

Origin.—About once in thirteen cases it varies in its origin, and, with one exception, in which it arose two or three inches below the elbow, it was given off either from the axillary or brachial, but very frequently from the latter. Gruber in a case of high origin of this vessel noticed a transverse branch connecting it, opposite the elbow, with the brachial.

Course.—Its position is more variable than that of the radial. When arising high up it nearly always is superficial to the superficial flexors (one exception has been noted), but is beneath the deep fascia; it may, however, be subcutaneous. In one case of high origin it divided subcutaneously into the superficial and deep branch. When the vessel is subcutaneous, it may continue in that position or become sub-aponeurotic lower down, and be distributed in the usual manner. The vessel from which the high ulnar comes afterwards divides into the radial and common interosseous, the latter being usually a branch of the ulnar. It is therefore probable that this unusual arrangement is a consequence of an early obstruction of the ulnar artery below the origin of the interosseous, and the development of a superficial *vasa aberrans* which unites the part of the ulnar below the obstruction with the axillary or brachial.

In these abnormalities the interosseous comprises the portion of the ulnar above the obstruction as well as the ordinary interosseous branch, and this view is borne out by the fact that the recurrent ulnar branches come from it.

Its *size* may vary and is often accompanied by opposite and compensating divisions in the radial.

Branches.—Both ulnar recurrents have been seen to come from the lower part of the brachial, and they frequently arise from the ulnar by a common trunk.

The *Common Interosseous* may arise from the brachial, and much more

rarely from the axillary, and the anterior and posterior interosseous vessels are sometimes derived separately from the ulnar. Occasionally the branches of the anterior interosseous are numerous and large, this condition being

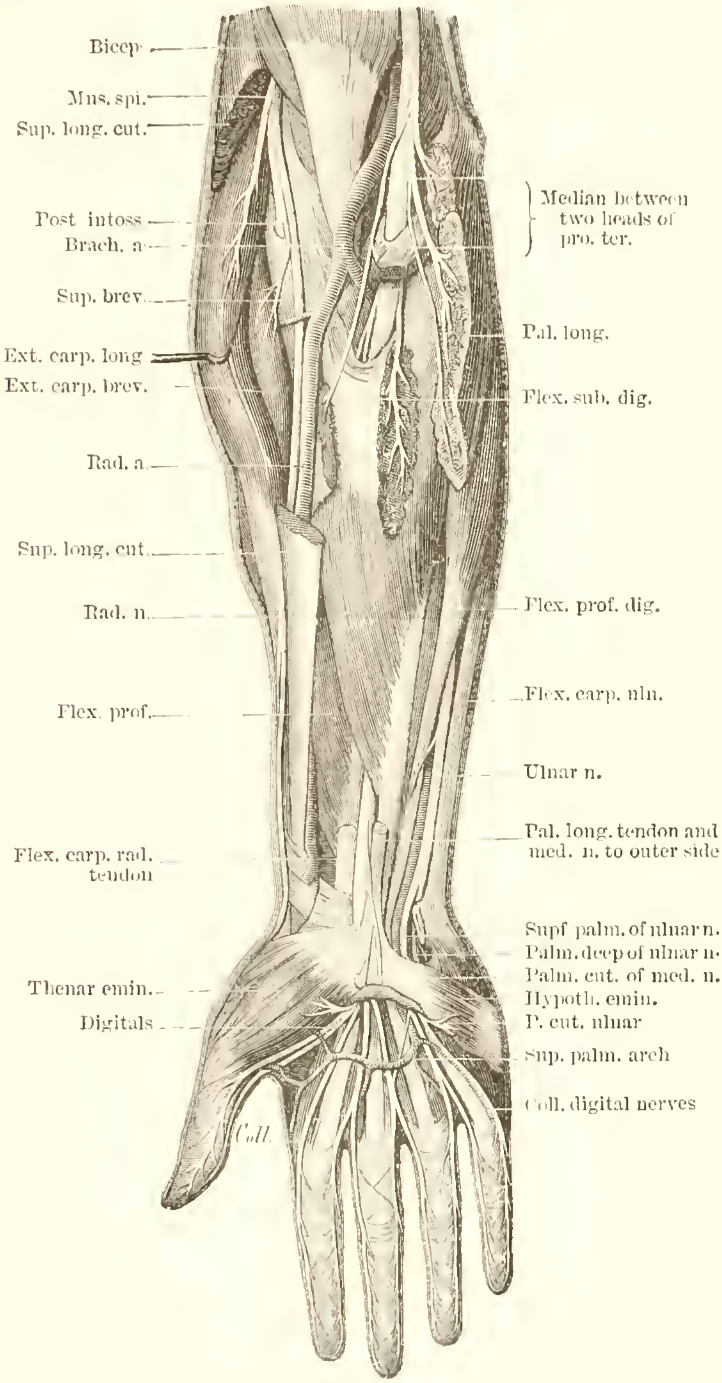


FIG. 143.—NERVES AND ARTERIES OF RIGHT FOREARM AND HAND. SUPERFICIAL DISSECTION.

The ulnar artery is seen just above the wrist to the radial side of the nerve. Some of the muscular branches of the median and musculo spiral are shown.

usually associated with a deficiency in the radial or ulnar arteries. The most important of these variations is the enlargement of the median branch of the anterior interosseous.

The *Median Artery*, or *Comes Nervi Mediani*, is occasionally very large and may be regarded as a reinforcing vessel. It usually comes from the anterior interosseous, but sometimes from the ulnar, and very rarely from the brachial. It accompanies the median nerve beneath the anterior annular ligament into the palm, and usually ends by joining the superficial arch.

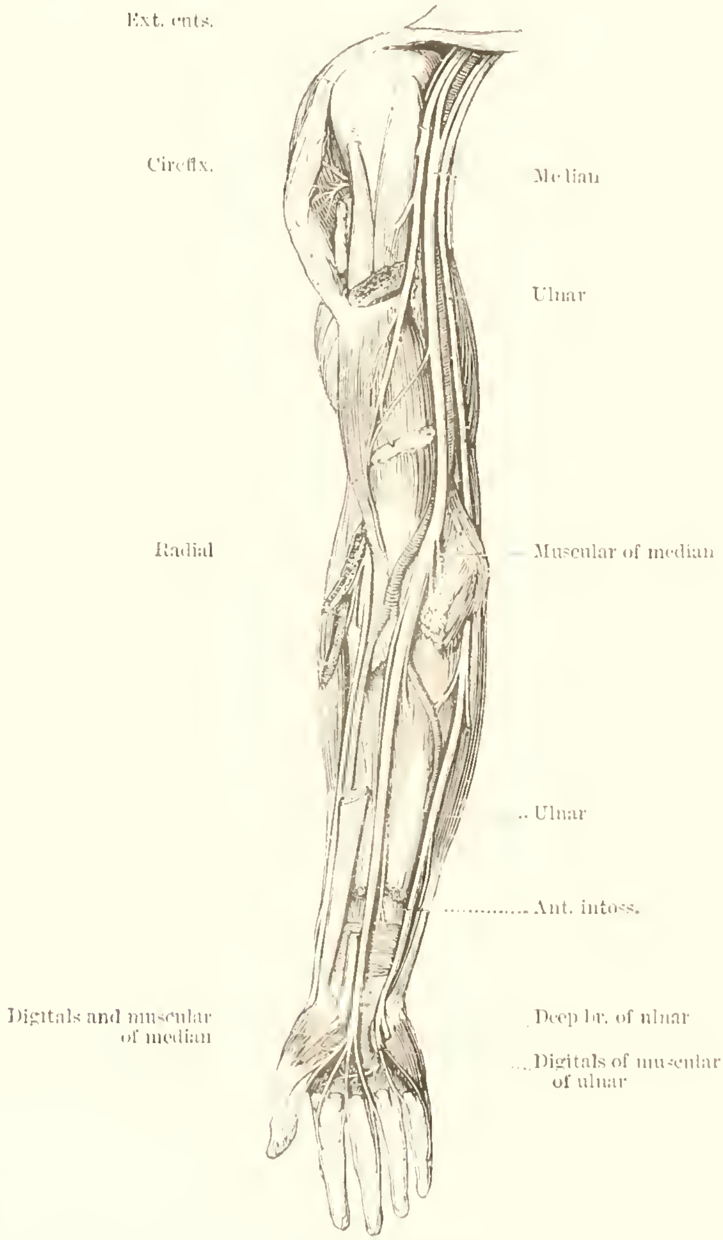


FIG. 111.—DISSECTION OF THE LARGER NERVES OF THE RIGHT UPPER LIMB.

An unusual communication between the median and musculo-cutaneous is represented.

Sometimes it gives off digital branches, and in other cases it joins digital vessels coming from other sources.

The **Ulnar Nerve** enters the forearm between the inner condyle and olecranon, and also between the two heads of the flexor carpi ulnaris, and descends in a straight course along the ulnar side of the forearm, internal to the artery, resting on the flexor profundus, its upper half being covered

by the flexor carpi ulnaris, and its lower half being on the outer side of the muscle beneath the skin and fascia. It is some distance from the upper third of the ulnar artery, but is close along its inner side for its lower two-thirds.

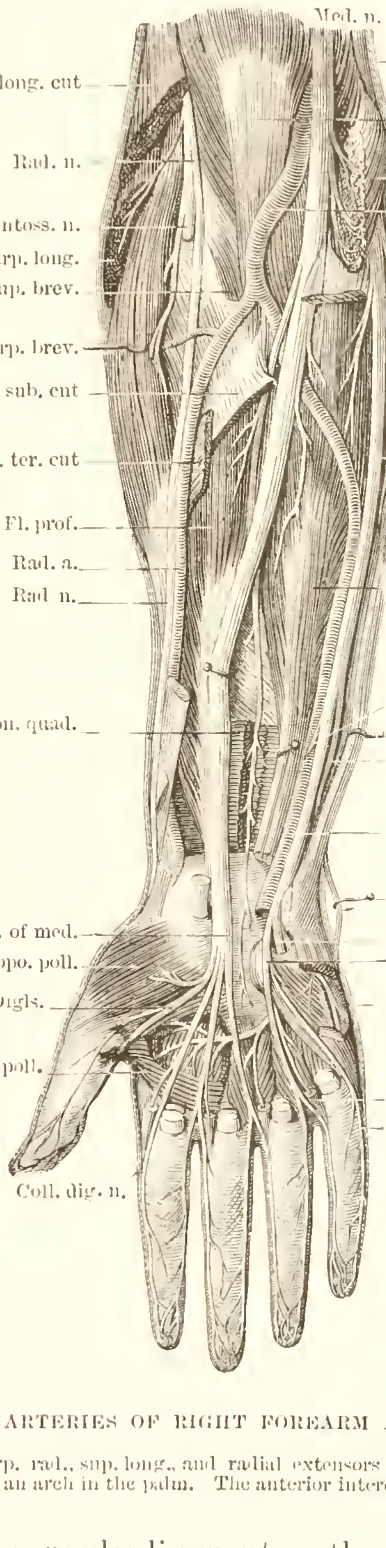


FIG. 145.—NERVES AND ARTERIES OF RIGHT FOREARM AND HAND. DEEP DISSECTION.

The cut tendons of the flex. carp. rad., sup. long., and radial extensors are seen; also the deep branch of ulnar nerve, forming an arch in the palm. The anterior interosseous nerve is shown.

It crosses the anterior annular ligament on the radial side of the pisiform bone a little internal and posterior to the artery, and then divides into a superficial and deep palmar branch.

Its *branches* in the forearm are articular, muscular, anterior, and posterior cutaneous, the latter being given off about two inches above the wrist.

The *Articular* branches are upper and lower. The former consist of several small filaments and supply the elbow joint, being given off in the groove between the inner condyle and olecranon. The latter supply the wrist joint.

FIG. 116.—EXTERNAL ASPECT OF RIGHT FOREARM, SHOWING BRANCHES OF MUSCULO-SPIRAL NERVE.

The *Muscular* branches are two, one for the flexor carpi ulnaris, the other for the inner half of the flexor profundus digitorum. The former enters the upper part of the muscle. Both are given off near the elbow.

The *Cutaneous* branches are anterior and posterior. The latter has been dissected with the back of the forearm, and the former arises about the middle of the forearm and divides into a superficial and deep branch.

The *Superficial* pierces the deep fascia near the wrist, supplies the skin and joins a branch of the internal cutaneous nerve. This branch is frequently absent. The *deep* branch lies on the ulnar artery and twining around the vessel ends in the skin of the palm, anastomosing with filaments of the median and ulnar nerves.

Varieties.—Usually the ulnar nerve gives off no branches in the arm, but sometimes small branches have been seen to supply the inner head of the triceps. Gruber has noticed the nerve passing in front of the inner condyle in three cases. And Turner has recorded an instance in which this nerve gave two branches to the flexor sublimis digitorum. Henle says, that the usual anastomosis between the median and ulnar digitals may be wanting. I have seen cases in which the junction between these digital nerves has been sparse.

The **Median Nerve** passes into the forearm between the two heads of the pronator teres and separates it from the ulnar artery by the deep head of that muscle, and courses down the front of the forearm between the sublime and deep flexors. Near the wrist it is superficial, lying beneath the fascia, between the tendons of the flexor sublimis and flexor carpi radialis, to the inner side of the palmaris tendon. It enters the palm beneath the anterior annular ligament resting on the flexor tendons. It is here somewhat enlarged and of a reddish colour, and divides into two nearly equal branches which are external and internal.

Branches.—In the *forearm* these are muscular, anterior interosseous, and palmar cutaneous.

The *Muscular* branches are given off near the elbow, but that to the pronator teres often arises above the joint. They supply all the superficial muscles except the flexor ulnaris, and, indirectly, the median by its anterior interosseous branch, supplies the deep layer, except the inner two divisions of the flexor profundus.

The *Anterior Interosseous* nerve is the longest branch of the median, is given off at the upper part of the forearm, and accompanies the anterior interosseous artery on the interosseous membrane, supplying the deep muscles, namely, the flexor carpi ulnaris, the flexor longus pollicis, pronator quadratus, and the outer half of the profundus digitorum. It lies between the flexor longus pollicis and profundus digitorum, and ends in the pronator quadratus.

The *Palmar Cutaneous Branch* arises at the lower part of the forearm, pierces the deep fascia just above the annular ligament, and crossing the ligament, supplies the skin about the middle of the palm, then divides into two branches, the *outer* of which supplies the skin over the ball of the thumb, and joins the external cutaneous nerve or radial. The *inner* branch supplies the skin of the palm, anastomosing with the palmar cutaneous of the ulnar.

The **Radial Nerve** is the smaller of the two terminal branches of the musculo-spiral, and it is given off in front of the external condyle, beneath the supinator longus and a little external to the radial artery. In the middle third of the arm it is in close relation with the outer side of the artery beneath the supinator longus, and about three inches above the wrist it passes beneath the posterior border of the tendon of the long supinator, pierces the deep fascia, and divides into an external and internal branch. No branches are given from the radial while it is sub-aponeurotic.

These branches have been described with the dissection of the back of the forearm, but it may be here mentioned that the internal branch communicates above the wrist with the branch from the external cutaneous nerve.

Dissection.—To expose the deep layer of muscles, divide the pronator teres or draw it to the radial side of the forearm. The other flexors should be divided about their middle, being careful of the median nerve between the sublime and deep flexors. Clean the muscles and define the anterior interosseous vessels and nerve, and the carpal arteries. The deep horizontal process of fascia must be removed to expose these structures.

FIG. 117.—DEEPEST LAYER OF THE FOREARM MUSCLES. RIGHT SIDE.

Deep Muscles of the Anterior Brachial Region.—There are but three muscles in this layer. The flexor profundus digitorum, lying on the ulnar side; the flexor longus pollicis, on the radial side; and the pronator quadratus is between the bones near their lower ends, and beneath the tendons of the others.

The **Flexor Profundus Digitorum** or **Perforans** is a large thick muscle arising from the upper two-thirds of the anterior and inner surfaces of the shaft of the ulna enclosing the insertion of the brachialis anticus above, and below extending to near the pronator quadratus. It also takes origin

from a depression on the inner side of the coronoid process, and by a strong aponeurosis from the upper two-thirds of the posterior border of the ulna, and from the ulnar half of the interosseous membrane. These fibres form a fleshy belly of large size, which ends in four tendons that pass under the annular ligament beneath the tendons of the flexor sublimis, and after piercing the sublimis, are inserted into the bases of the last phalanges. The tendon for the index finger is separated from the others above the wrist, the rest being connected together by tendinous slips and cellular tissue as far as the palm.

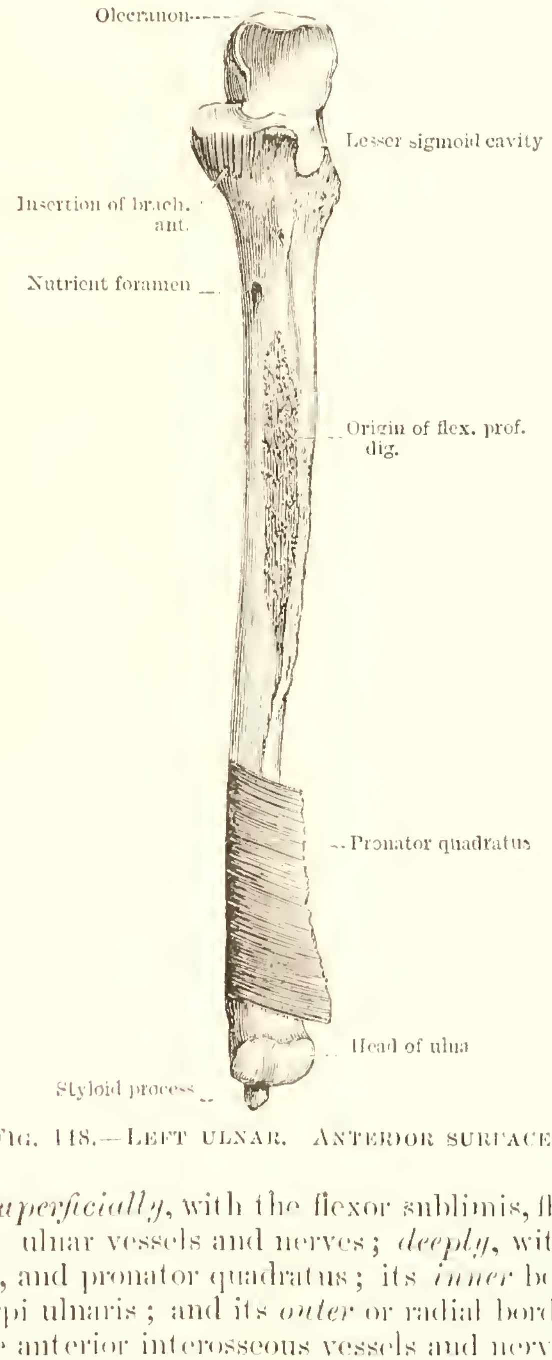


FIG. 118.—LEFT ULNAR. ANTERIOR SURFACE.

Relations.—Superficially, with the flexor sublimis, flexor carpi ulnaris, median nerve, and ulnar vessels and nerves; *deeply*, with the ulna, interosseous membrane, and pronator quadratus; its *inner* border is in relation with the flexor carpi ulnaris; and its *outer* or radial border with the flexor longus pollicis, the anterior interosseous vessels and nerve intervening.

Actions.—It flexes the distal phalanges, and then bends the wrist, but it does not act on the last phalanges after the second have been bent by

the flexor sublimis, unless the second be previously fixed. It first flexes the joint between the middle and metacarpal phalanges, then the last phalangeal joint, and thirdly the metacarpo-phalangeal articulation; but the latter can be fixed by the extensors, while the inter-phalangeal joints are bent by the superficial and deep flexors.

Nerve.—The inner half by the ulnar, and outer half by the anterior interosseous.

Varieties.—It may partly arise from the inner humeral condyle, or from the radius, or may have a distinct slip from the coronoid process of the ulna. It is pretty often connected with the flexor sublimis or longus pollicis. The slip from the coronoid process often constitutes a supplementary or accessory muscle, which variously joins one of the perforating tendons.

FIG. 119. DIAGRAM OF THE MUSCULAR ATTACHMENTS ON THE FRONT OF THE RIGHT FOREARM.

The orbicular ligament and interosseous membrane are represented.

The **Flexor Longus Pollicis** arises from the upper two-thirds of the anterior grooved surface of the radius from the oblique line to the upper edge of the pronator quadratus, also from the adjoining part of the interosseous ligament, and sometimes by a round fleshy and tendinous slip, distinct from the rest of the muscle, from the inner part of the coronoid process of the ulna. This slip is internal to the attachment of the brachialis anticus. The fleshy fibres end in a flattened tendon which passes beneath the annular ligament and between the heads of the flexor brevis pollicis, then enters an osseo-fibrous canal, and is inserted into the base of the last phalanx of the thumb.

Relations.—*Superficially*, with the flexor sublimis, flexor carpi radialis, supinator longus and radial vessels; *deeply*, with the radius, interosseous membrane and pronator quadratus. Its *ulnar* border is in relation with the flexor profundus digitorum, the anterior interosseous vessels and nerve intervening.

Actions.—It at first bends the distal phalanx, then the proximal, and can afterwards flex the wrist, drawing it somewhat inwards in consequence of its oblique direction.

Nerve.—The anterior interosseous.

FIG. 150.—LEFT HUMERUS. ANTERIOR SURFACE.

Varieties.—In two-fifths of the subjects dissected by Macalister, he found a second or accessory tendon for the thumb. This may arise from the inner condyle, the coronoid process or from the flexor sublimis. The flexor longus pollicis may be connected by a slip with the sublime or deep flexor or the pronator teres. A tendon of insertion into the index finger has also been noticed.

The **Pronator Quadratus** is a flat quadrilateral muscle, passing transversely across the front of the lower part of the radius and ulna. It arises from the oblique line on the lower fourth of the anterior surface of the

ulna, and from part of the bone below it; also from the anterior border of the ulna, and from a strong aponeurosis which covers the inner third of the muscle. The fibres pass, some transversely, and others obliquely out, to be inserted into the lower fourth of the anterior surface and external border of the radius, where it is rather narrower.

Relations.—*Superficially*, with the flexor profundus, flexor longus pollicis, flexor carpi radialis and radial vessels; *deeply*, with the radius, ulna, interosseous membrane and interosseous vessels and nerve; along its *lower* border is the anterior carpal arch; and above its *upper* the anterior interosseous artery passes to the back of the forearm.

Action.—The radius is moved forwards over the ulna and the hand pronated by this muscle.

Nerve.—Anterior Interosseous.

Varieties.—It is very rarely absent, but may be subdivided into two or three layers, or it may extend further up on the forearm bones than usual. It may be prolonged down on the carpus, either on the radial side as a radial carpal, or on the ulnar as an ulnar carpal vessel.

The *Anterior Interosseous Artery* is a branch of the common interosseous of the ulna, and runs down in front of the interosseous membrane in company with the anterior interosseous nerve. A thin aponeurotic arch connects it to the interosseous ligament. It lies usually between the flexor longus pollicis and flexor profundus, but may run in the substance of the latter muscle. It gives off muscular twigs to the deep muscles and the *nutrient* arteries of the radius and ulna which run towards the elbow. At the upper border of the pronator quadratus a branch descends in front of that muscle, and anastomoses with recurrent branches from the anterior carpal and deep palmar arches. The continuation of the artery pierces the interosseous membrane, passing behind the pronatus quadratus, and descends to the back of the wrist to anastomose with the posterior interosseous artery and the posterior carpal branches of the radial and ulnar.

The *Median Artery* is a long branch of the anterior interosseous. It accompanies the median nerve, supplying it, and ends in the flexor sublimis, or passes beneath the annular ligament to the palmar arch.

The *Varieties* of the Median Artery have been given in describing those of the ulna.

The *Anterior Interosseous Nerve* comes from the median, gives lateral branches to the deep flexors, and ends in the under-surface of the pronator quadratus.

Directions.—The student should examine the insertion of the brachialis anticus and biceps, and the attachments of the other muscles connected with the forearm bones. He should note the change in the direction of the biceps tendon, its anterior surface becoming external and *vice versâ*, and observe how the supinator brevis surrounds its insertion. He should also define the bursa between the tendon and the forepart of the radial tubercle, and see if there be a *sesamoid* bone in the tendon. The anastomoses about the elbow should now be more thoroughly dissected.

Anastomoses around the Elbow Joint.—In *front* of the *inner* condyle, the anterior terminal twig of the inferior profunda, and part of the anastomotica magna join the anterior ulnar recurrent; *behind* the same condyle, the posterior terminal branch of the inferior profunda and a twig of the

anastomotica magna anastomose with the posterior ulnar recurrent; in *front* of the *outer* condyle, the superior profunda joins the radial recurrent: *behind* this condyle and between it and the olecranon, the posterior articular branch of the superior profunda unites with the posterior interosseous recurrent, and part of the superior profunda joins the anastomotica magna. There is also an anastomotic arch above the olecranon between the anastomotica magna, posterior ulnar recurrent, and posterior interosseous recurrent.

The student will observe that the anastomotica magna has most to do, and is only not engaged in this free anastomosis in the *front* of the outer condyle.

THE PALM OF THE HAND.

Dissection.—Make a longitudinal incision along the middle of the palm, and one transverse to it along the webs of the fingers, and reflect the skin in and out, being careful of the palmaris brevis beneath the inner flap and the palmar cutaneous branches of the median and ulnar nerves. The palmar fascia and palmaris brevis should be cleaned, and the transverse ligament at the roots of the fingers must be preserved. Just above the digital commissures, between the processes of the palmar fascia, the digital vessels and nerves will be perceived. Those for the outer side of the index finger and the inner side of the little finger become apparent rather farther back than the others. Between the digital vessels and nerves the lumbricales muscles will be observed.

The skin and subcutaneous fatty tissue must be carefully removed from the fingers and thumb by an incision along the middle of each, so that the sheaths of the flexor tendons, the cutaneous ligaments, and the collateral digital vessels and nerves and lymphatics may be exposed.

Cutaneous Ligaments of the Phalanges.—Prof. Cleland, in 1867, in the 'Report of the Proceedings of the British Association,' stated 'that strong ligaments, hitherto undescribed, extend from the sides of the phalanges, near the phalangeal articulations, and are inserted into the skin, helping to retain the different parts of the integument in the positions which they are adapted to occupy.' He also describes them in the 'Journal of Anatomy,' vol. xii. p. 5.

These ligaments are very constant structures; those at the first digital interphalangeal joint are well developed, and also those at the interphalangeal joint of the thumb; and a similar though distinct arrangement can be seen at the distal joints of the fingers and toes. At the first interphalangeal articulation a strong band of fibres arises from the lateral ridge of the first phalanx in the distal half of its extent, some of them within and some without the grasp of the ligamentum vaginale, and joining this band are a few fibres coming from the lateral prominence of the base of the second phalanx. This band passes down behind the digital artery and nerve, and its fibres spread out on reaching the skin, those on the palmar aspect turning over to the mid-line of the finger. A smaller decussating band is situated behind this, and it arises from the lateral ridge of the second phalanx and passes up by the side of the first phalanx to its insertion into the skin.

At the last joint of the fingers the chief band passes up from the lateral prominence at the base of the last phalanx, and is strengthened by

fibres from the rough expansion of the distal extremity of the phalanx, while others pass directly to the skin behind this band. The general result of this arrangement may be described as being the formation of a fibrous septum on each side of each finger, lying immediately behind the palmar digital branches of artery and nerve, and their chief use seems to be to keep in their places the parts of the integument at the backs of the joints during flexion and extension, and to prevent bagging of the skin at the sides of the joints during flexion.[1]

Cutaneous Nerves of the Palm.—These come from the median and ulnar nerves, which give some unnamed filaments to the skin, and the two palmar cutaneous nerves.

The *Palmar Cutaneous* of the *Median* crosses the anterior annular ligament in two branches; the inner extends to near the middle of the palm, joining the palmar branch of the ulnar, and the outer gives branches to the skin over the thenar eminence, and anastomoses with the anterior branch of the external cutaneous nerve.

The *Palmar Cutaneous Branch* of the ulnar crosses the anterior annular ligament on the ulnar artery, entwining round it, and accompanying it to

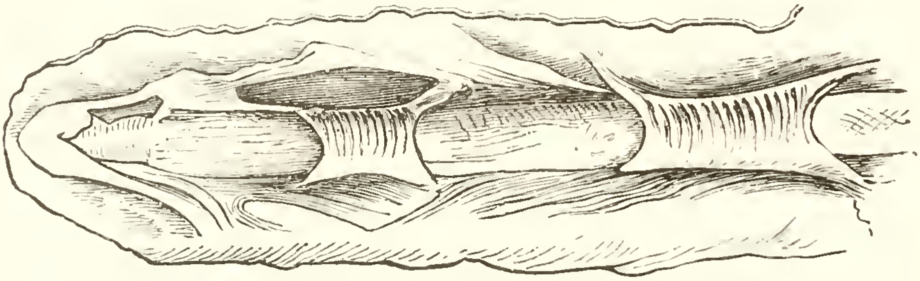


FIG. 151.—CUTANEOUS LIGAMENTS OF FINGERS (CLELAND).

the palm, supplying the skin and joining the corresponding branches of the median nerve.

The **Palmaris Brevis** is a thin quadrilateral subcutaneous muscle, about two inches wide on the ulnar side of the hand. Its fibres are collected into separate bundles, and *arise* by tendinous fasciculi from the annular ligament and middle piece of the palmar fascia. Its fleshy fibres pass horizontally to be *inserted* into the skin over the hypothenar eminence.

Relations.—*Superficially*, with the skin, to which it is closely adherent at its inner part; *deeply*, with the inner piece of the palmar fascia, which separates it from the ulnar vessels and nerves, and from the muscles of the little finger.

Action.—It draws the skin of the inner side of the hand towards the centre and deepens the hollow of the palm.

Nerve.—The ulnar.

Varieties.—It is sometimes entirely absent, and occasionally blends with the flexor brevis minimi digiti. There is considerable variation in its breadth, thickness, the strength of its fibres, and also their length and direction. It sometimes consists of only a few scattered fibres.

[1] These ligaments were described by a German before Dr. Cleland's first description, but not so completely as by him. See an early number of the *Jahresberichte für Anat. und Physiologie*, edited by Hofman and Schwalbe.

Directions.—Reflect this muscle inwards, so as to completely expose the palmar fascia.

The *Palmar Fascia* or *Aponeurosis* invests the muscles and tendons in a common sheath, and consists of a central and two lateral parts. The *central portion* is a triangular, strong, thick, whitish glistening structure, with its apex near the wrist, and its base towards the fingers. It binds down the tendons and nearly covers the palm at its lower end. Its apex

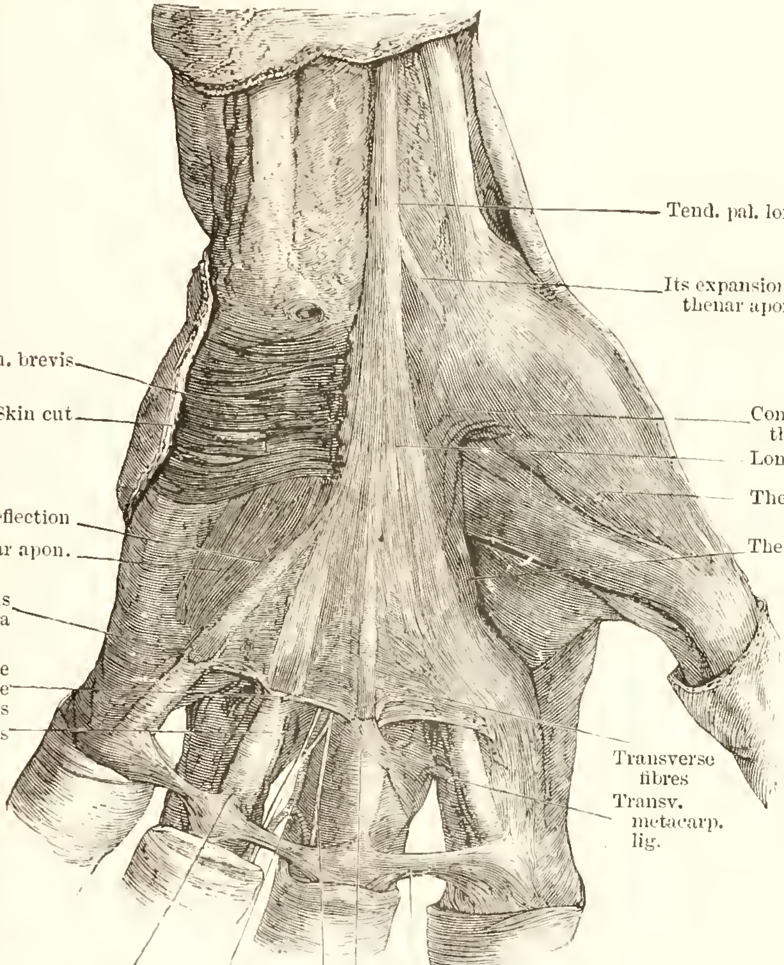


FIG. 152. PALMAR FASCIA OF LEFT HAND.

is attached to the lower border of the annular ligament and receives the expanded tendon of the palmaris longus. Its base divides opposite the heads of the metacarpal bones into four processes for the fingers. Each slip or process divides into two others, which enclose the tendons of the superficial and deep flexors, and are attached to the glenoid ligament and sides of the first phalanges, also to the edges of the metacarpal bones, and

to the deep transverse ligament which connects them together near their heads, forming four arches under which the flexor tendons pass. Some strongish transverse fibres (the superficial transverse ligament) connect these processes at their point of separation, and beneath them pass the digital vessels and nerves and the tendons of the lumbricales. Each process of the fascia sends a few superficial longitudinal fibres to the skin between the finger clefts. The *superficial* surface of this fascia is closely

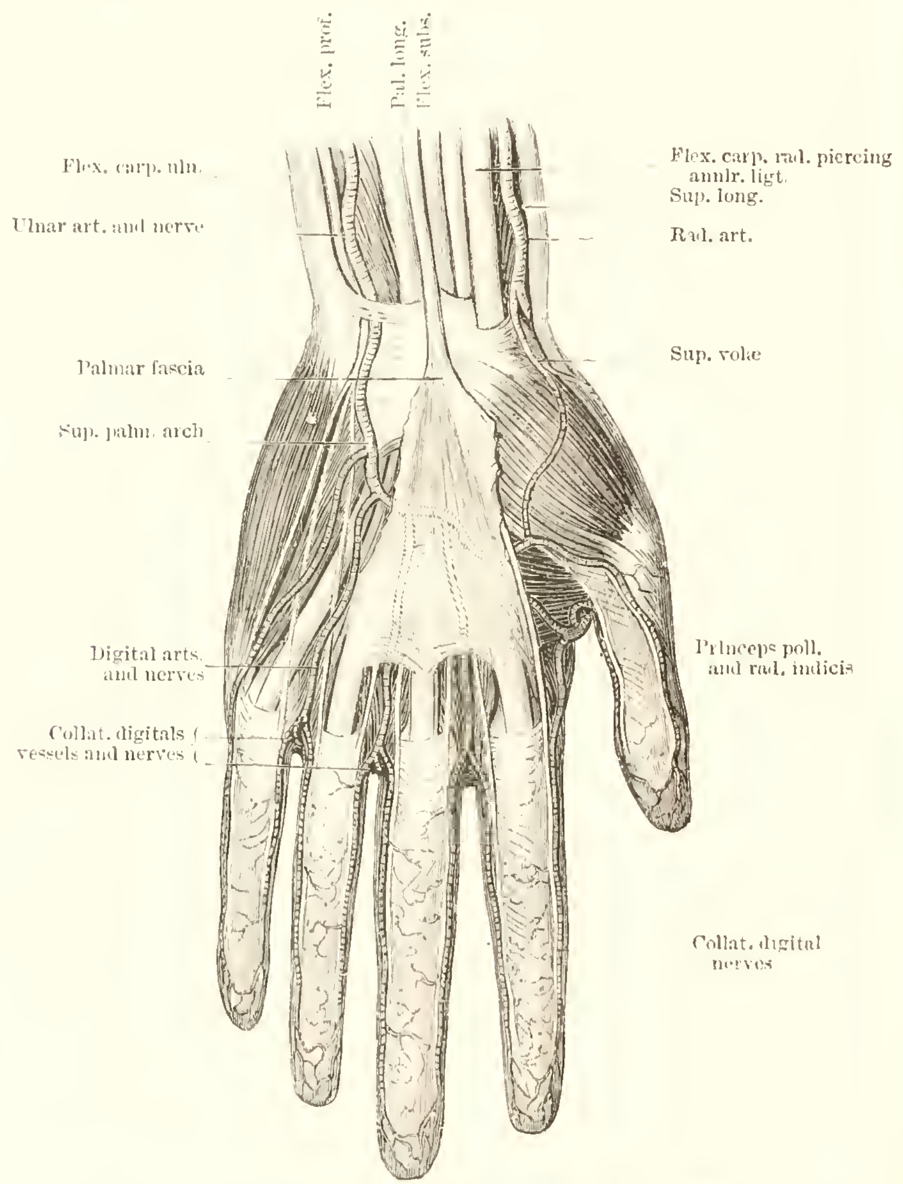


FIG. 153. SUPERFICIAL PALMAR REGION, LEFT HAND.

The palmar fascia is supposed transparent, showing the arch dotted. The flexor sheaths are preserved.

united to the skin by many fibrous bands, and gives origin by its inner margin to the palmaris brevis. Its *deep* surface covers the superficial palmar arch, the tendons of the flexors with their synovial sheaths, and the branches of the median and ulnar nerves. On each side this central piece gives off a vertical septum which is continuous with the aponeurosis

of the interossei muscles, and which separates the lateral from the middle palmar muscles.

The *Lateral Portions* of the Palmar Fascia are thin fibrous laminae, covering on the radial side the muscles of the thumb, and on the ulnar side those of the little finger. They are continuous with the middle piece of the palmar fascia, and with the dorsal fascia on the inner and outer sides of the borders of the hand.

Dissection.—One of the processes of the palmar fascia should be traced

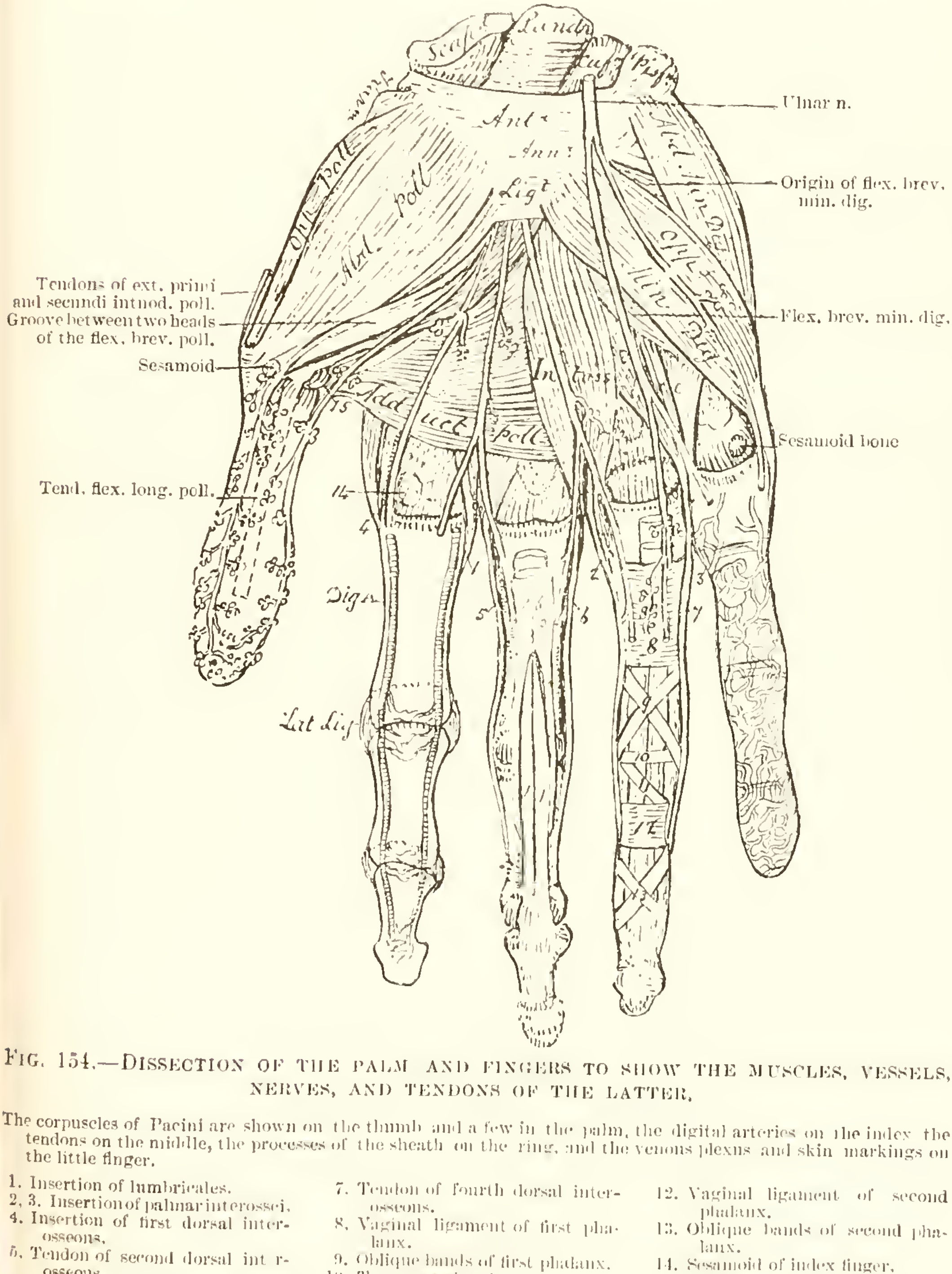


FIG. 154.—DISSECTION OF THE PALM AND FINGERS TO SHOW THE MUSCLES, VESSELS, NERVES, AND TENDONS OF THE LATTER.

The corpuscles of Pacini are shown on the thumb and a few in the palm, the digital arteries on the index, the tendons on the middle, the processes of the sheath on the ring, and the venous plexus and skin markings on the little finger.

1. Insertion of lumbricales.
2, 3. Insertion of palmar interossei.
4. Insertion of first dorsal interosseous.
5. Tendon of second dorsal interosseous.
6. Tendon of third dorsal interosseous.
7. Tendon of fourth dorsal interosseous.
8. Vaginal ligament of first phalanx.
9. Oblique bands of first phalanx.
10. Transverse band.
11. Oblique band.
12. Vaginal ligament of second phalanx.
13. Oblique bands of second phalanx.
14. Sesamoid of index finger.
15. Inner sesamoid of thumb.
16. Tendon of flex. sub. dig.
17. Tendon of flex. prof. dig.

to its termination by inserting the scalpel beneath it opposite the head of one metacarpal bone and dividing it longitudinally. Its attachments, as described, can then be made out. The sheath of the flexor tendons should also be studied along one or two of the fingers by slitting it up carefully

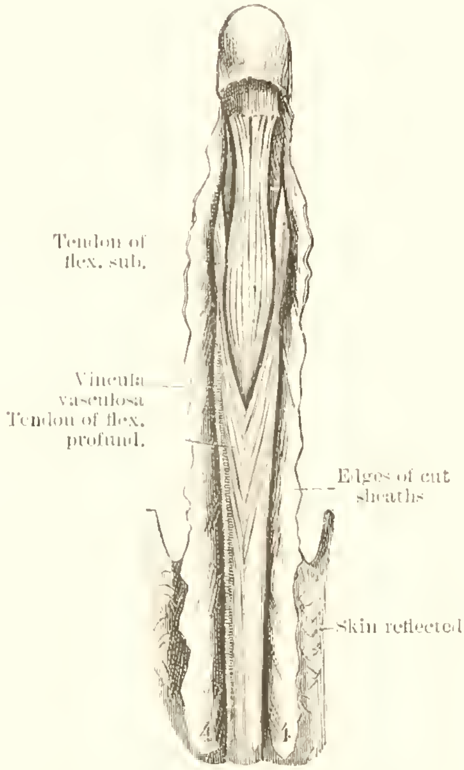


FIG. 155.—FLEXOR TENDONS *in situ*; THE SHEATH REFLECTED.

in the mid-line to the finger tips. The processes from the sheaths to the tendons and the vascular fringes of the synovial lining must be examined. A blowpipe may be cautiously inserted between the tendons and the

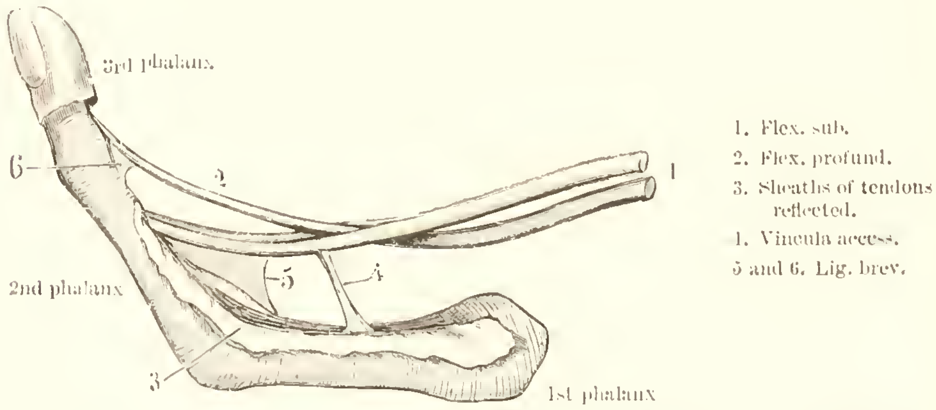


FIG. 156.—FLEXOR TENDONS AND THEIR ATTACHMENTS AND PROCESSES.

synovial sheath, and the latter demonstrated after being distended with air.

The *Sheaths of the Flexor Tendons*.—The tendons of the flexor sublimis and profundus are kept in position along each of the digits by a

fibrous sheath which is partly formed by the processes of the palmar fascia. Opposite the middle of the first and second phalanges the sheaths consist of strong tendinous transverse bands (*ligamenta vaginalia*), which are

FIG. 157.—DIGITAL LYMPHATICS AND THEIR PLEXUSES, SHOWING THE ULNAR SIDE OF A FINGER AND THE ANASTOMES ACROSS THE DORSUM.

attached to the lateral margins of the palmar surfaces of the phalanges. Opposite the inter-phalangeal joints the sheath is thin, but is strengthened

FIG. 158.—COLLATERAL DIGITAL NERVES OF FINGER.

by oblique decussating fibres. Some slender loose tendinous bands pass from the floor of the sheath to the deep surfaces of both tendons (*vincula*

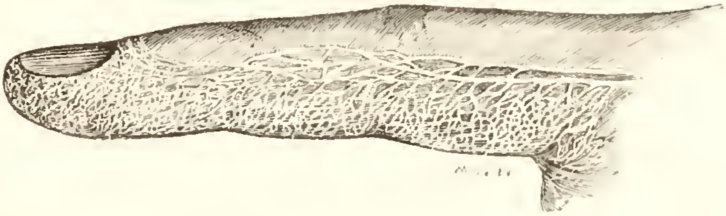


FIG. 159.—LYMPHATICS OF RADIAL SIDE OF A RIGHT FINGER.

Two large branches and their anastomoses and plexuses are shown.

accessoria tendinum). Behind each tendon, near its insertion, a short membranous structure fixes its corresponding tendon to the front of the

phalanx above that into which it is inserted (*ligamenta brevia*). Each tendinous sheath has a synovial membrane which in the palm passes between the tendons. In the sheaths these synovial membranes form slender and long vascular folds between the tendons and the bones (vincula vasculosa). The thinness of the sheaths opposite the joints permits of free flexion and extension.

Dissection.—The student should now dissect out the digital vessels and nerves and lymphatics of one finger. These will be fully described further on, but the accompanying figures will guide him in his dissection. He should then remove the palmar fascia carefully, so as to expose the superficial palmar arch, and the branches of the median and ulnar nerves,

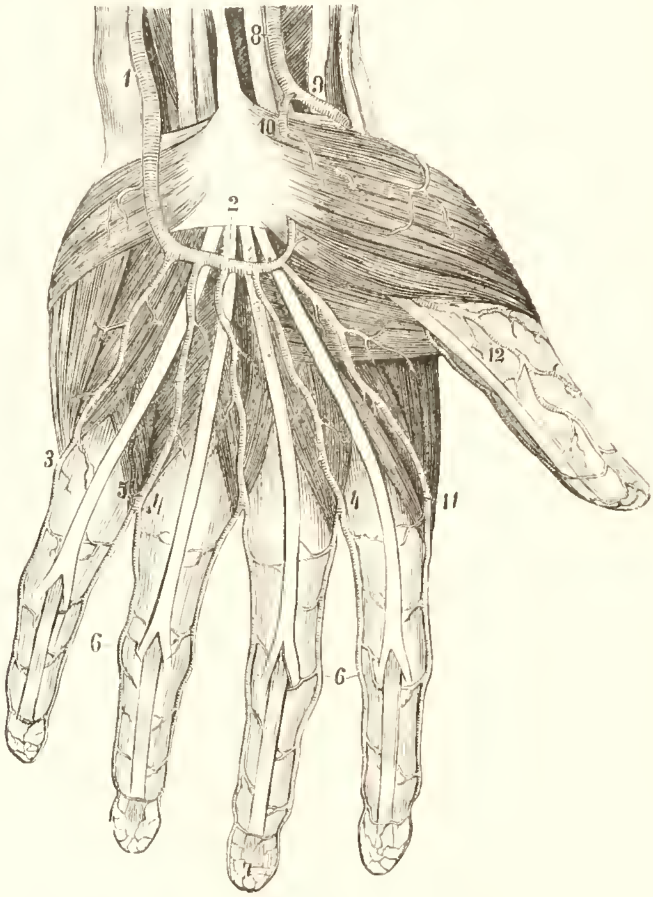


FIG. 160.—THE LEFT SUPERFICIAL PALMAR ARCH.

after having cleaned the sheath of one finger, and having become familiar with the arrangement of the flexor sheath in its entirety.

Superficial Palmar Arch.—The ulnar artery passes obliquely outwards to the thumb muscles, where it sometimes joins the superficialis volæ from the radial, and commonly inosculates with the radialis indicis branch of the same vessel, thus completing the palmar arch. The convexity of this arch is towards the fingers, and its position will be pretty accurately indicated by a line, drawn across the hand corresponding to the lower margin of the thumb when that is at right angles with the fingers. The deep palmar arch is about a finger's breadth nearer the wrist.

Relations.—It is *superficial*, being covered by the skin, palmar fascia,

and palmaris brevis at the inner side; *behind* it are the anterior annular ligament, the muscles of the little finger, the tendons of the flexor sublimis and profundus, and the branches of the median and ulnar nerves. Venæ comites accompany the ulnar artery, as also does the ulnar nerve for a short part of its course.

Branches.—Some small twigs to the palm of the hand are given off from the concavity of the arch. A small profunda branch comes from it as soon as the artery enters the palm, and the digital branches are given off from the convexity of the arch.

The *Deep Communicating* or *Profunda Branch* is small and passes deeply inwards with the deep branch of the ulnar nerve, between the abductor and flexor brevis minimi digiti near their origins. It joins the termination of the radial artery near the inner border of the hand to form the deep palmar arch.

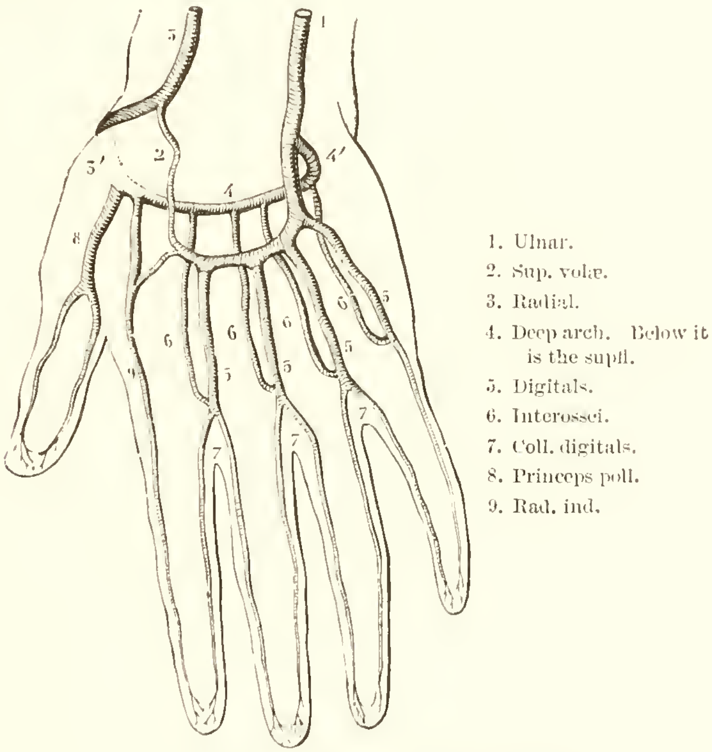


FIG. 161.—DIAGRAM OF THE PALMAR ARCHES.

The *Digital Branches* are four, and supply the inner side of the little finger, the adjoining sides of the three inner fingers, and the inner side of the index finger, on their palmar aspects. The contiguous sides of the index finger and thumb are supplied by the radial artery. The branch which supplies the inner side to the hand and little finger is undivided, but the others bifurcate near the finger webs to furnish the *collateral digital* arteries. In the hand these vessels lie at first superficial to the flexor tendons, and are accompanied by the digital nerves, which they occasionally pierce; but as they pass forwards with the nerves to the finger clefts they lie between them, and are there joined by the interosseous branches of the deep palmar arch. The artery for the inner side of the little finger has its communicating branch for the interosseous about the middle of the hand. On the sides of the fingers the digital arteries lie

beneath the nerves, and about the middle of the last phalanx the two vessels of each finger form an arch, from the convexity of which twigs are given off to supply the ball of the finger. These vessels give branches to the skin of the finger, the tendons and their sheaths, and also supply the phalangeal articulations and the periosteum. There is an arch close behind each joint from which twigs go to each articulation, and on the dorsum of

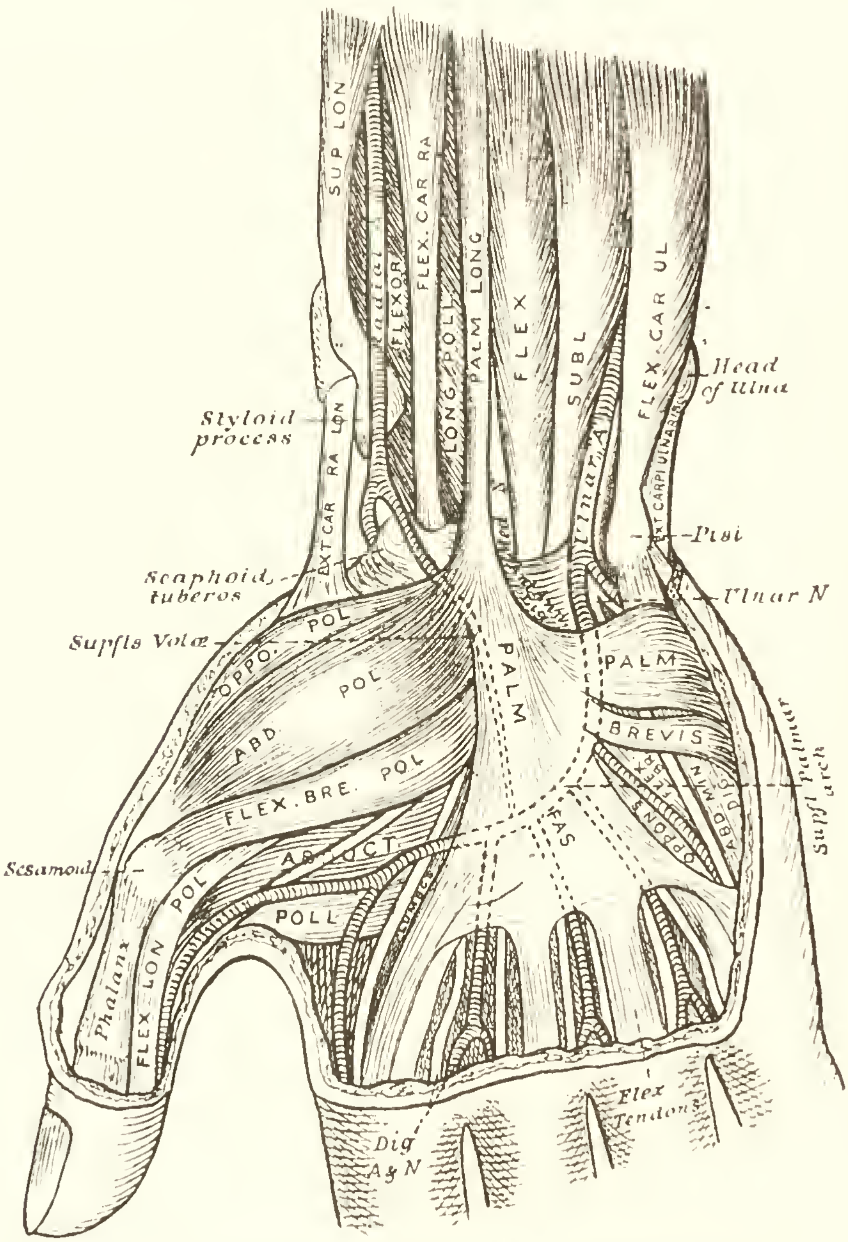


FIG. 162.—SUPERFICIAL DISSECTION OF THE RIGHT PALM.

the last phalanx, near the root of the nail, is another arch which supplies the matrix of the nail. These palmar digitals anastomose with the dorsal digitals which come from the interosseous branches of the radial.

The **Median Nerve in the Palm.**—In this situation the nerve is enlarged, flattened and reddish, and divides into two nearly equal branches. The *external* branch supplies some of the thumb muscles and digital branches

to the thumb and index finger. The *internal* branch supplies the contiguous sides of the index and middle, and of the middle and ring fingers.

The *Branch* of the *Thumb Muscles* is short and divides to supply the abductor, opponens, and outer head of the flexor brevis pollicis, the other thumb muscles being supplied by the ulnar nerve.

The *Digital Branches* are *five*. The *first* and *second* are distributed to the outer and inner borders of the thumb, the external branch joining the radial nerve. The *third* digital passes along the radial side of the index finger and supplies the first lumbricalis muscle. The *fourth*

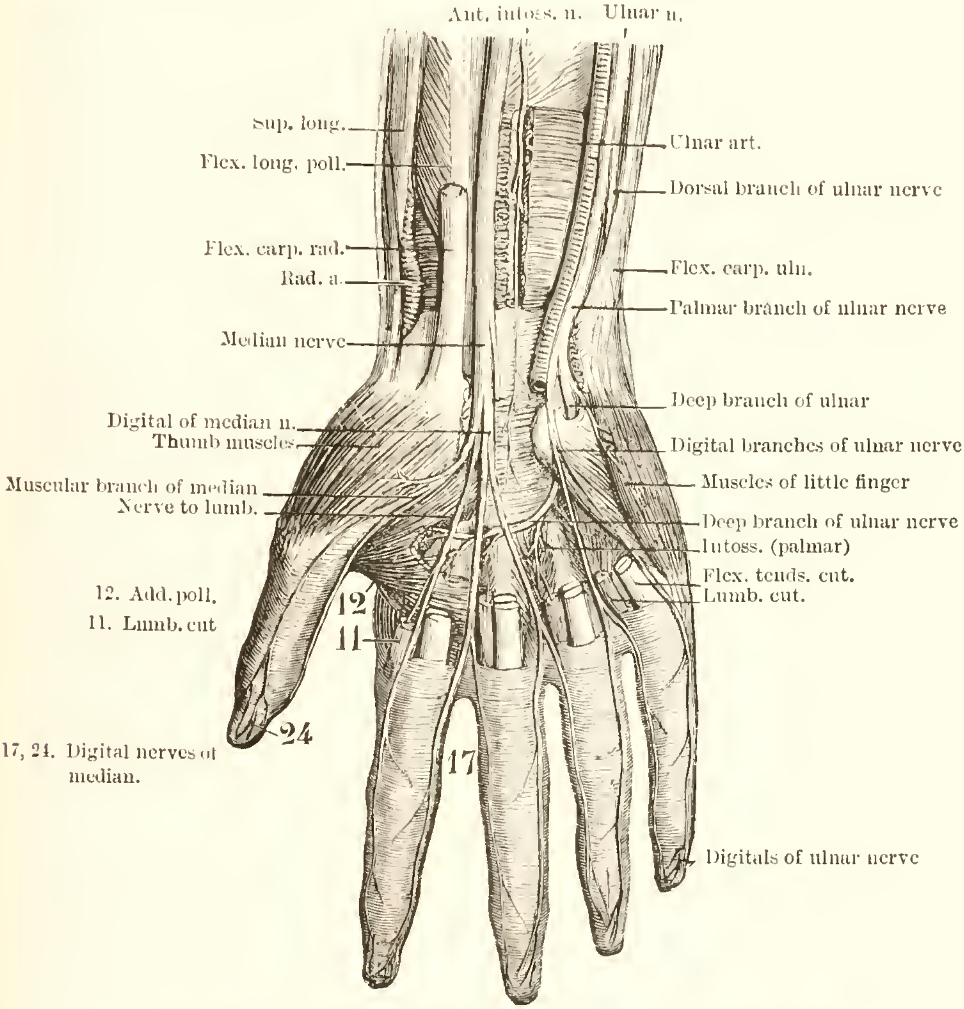


FIG. 163.—NERVES OF RIGHT HAND. DEEP DISSECTION.

The pronator quadratus is cut to show the ant. inteoss. nerve.

bifurcates at the web to supply the adjacent sides of the index and middle fingers and the second lumbricalis. The *fifth* supplies the contiguous sides of the middle and ring fingers and joins a branch of the ulnar nerve.

On the Fingers the nerves are superficial to the arteries and extend to the last phalanx, where they divide into a *palmar* and *dorsal* branch. The former supplies the ball of the finger, and the latter the nail pulp. Each nerve near the base of the first phalanx gives off a *dorsal* branch which joins the dorsal digital nerve, and runs along the side of the dorsum of the finger ending in the skin over the last phalanx.

The **Ulnar Nerve in the Palm.**—This nerve divides on or near the annular ligament into a superficial and deep branch. The *superficial* palmar branch supplies the palmaris brevis and the skin on the inner side of the hand, and ends in two digital branches, the *inner* of which supplies the ulnar side of the little finger, and the *outer* innervates the adjoining sides of the little and ring fingers and communicates with the median.[1]

The *Deep Palmar Branch* accompanies the deep branch of the ulnar artery and will be subsequently dissected. It can now be seen to pass between the abductor and flexor brevis minimi digiti, and to give twigs to the muscles of the little finger.

At the sides of the fingers the digital branches of the ulnar nerve have a similar arrangement to those of the median. Lymphatics accompany the digital vessels and nerves.

Dissection.—Divide the ulnar artery just below the origin of its deep branch, and sever it from its connection with the superficialis volæ, or radialis indicis, and reflect the superficial palmar arch towards the fingers. Divide the median and ulnar nerves just below the annular ligament and

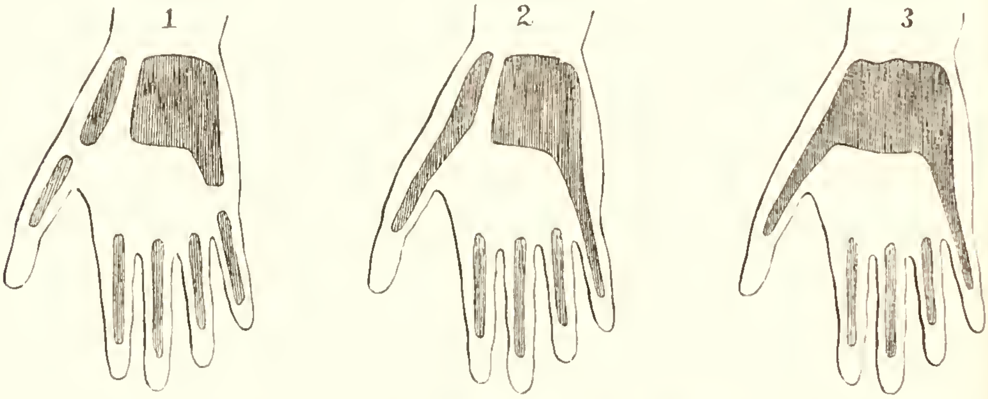


FIG. 164.—DIAGRAMS OF THE COMMONEST ARRANGEMENTS OF THE PALMAR SYNOVIAL SHEATHS.

No. 2 appears to be the more usual form.

throw them forwards. Make a longitudinal incision through the centre of the anterior annular ligament, preserving the origins of the muscles of the thumb and little finger, and reflect it. The arrangement of the flexor tendons can now be followed out.

Flexor Tendons.—Beneath the anterior annular ligament the tendons of the superficial and deep flexors are surrounded by a loose and large common synovial membrane, which projects above the ligament into the forearm, and downwards into the palm, sending an offset into the digital sheaths of the thumb and little fingers.

The *Synovial Sheaths.*—There are considerable variations in the arrangement, extent, and communications of the sheaths of the long flexors in the palm. The description about to be given, and which is diagrammatically represented in the accompanying woodcut, is about the most common, but the student may, by carefully inserting the blowpipe,

[1] Sometimes the ulnar supplies two and a half fingers, and the median the other two and a half.

distend these sheaths with air, or by injecting water, render them more apparent.

The *Common Synovial Sheath of the Flexor Sublimis and Profundus* extends from rather more than an inch above the annular ligament, where

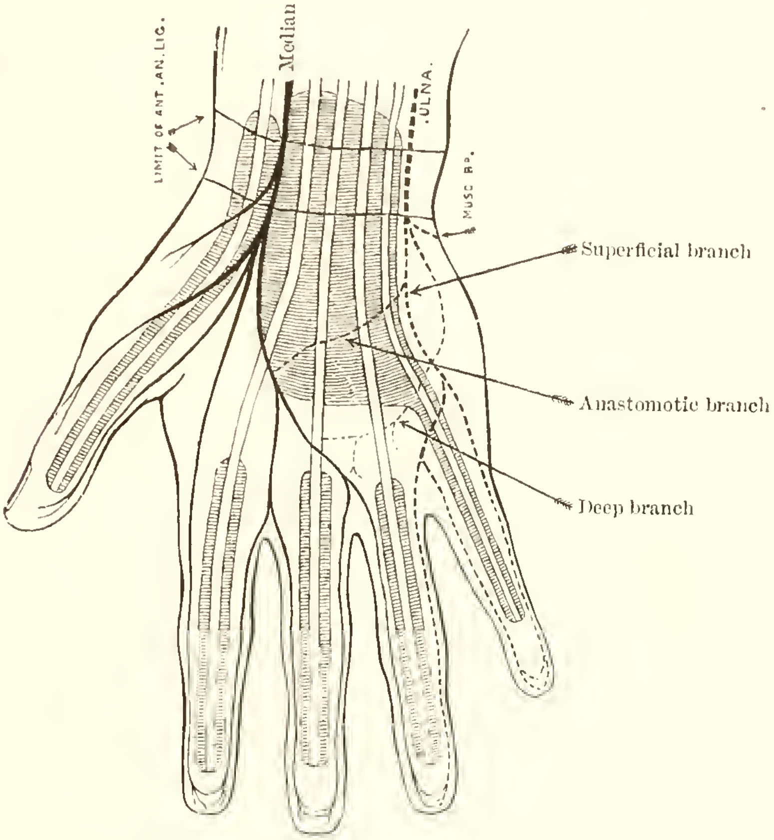


FIG. 165.—SYNOVIAL SHEATHS OF THE PALM AND DIGITS, AND DISTRIBUTION OF MEDIAN AND ULNAR NERVES OF RIGHT HAND.

it is separated from the sheath of the flexor longus pollicis by the median nerve, to about the middle of the palm, where it becomes broader and forms three prolongations. The first and second invest the tendons of

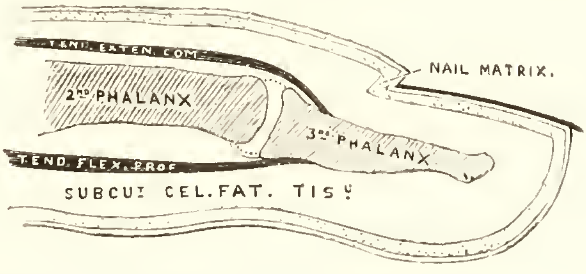


FIG. 166.—ANTERO-POSTERIOR VERTICAL SECTION THROUGH A FINGER TO SHOW INSERTIONS OF FLEX. PROF. AND EXTENSOR COMMUNIS.

the index and middle fingers, and the third is common to the tendons of the ring and little fingers.

The *Sheath of the Flexor Longus Pollicis.*—To see this the skin and sheath must be removed carefully from the tendon, if this have not been

already done. It extends rather less than an inch above the anterior annular ligament, and downwards to near the insertion of the muscle.

The *Digital Synovial Sheaths* for the index, middle, and ring fingers commence in *cul-de-sacs* a little on the palmar side of the metacarpo-phalangeal articulation, and extend to the middle of the last phalanges. The student will again note the *vincula vasculosa* which pass between the tendons, uniting them to each other and to the anterior aspect of the phalanges.

Tendons of the Flexor Sublimis Digitorum.—Beneath the anterior

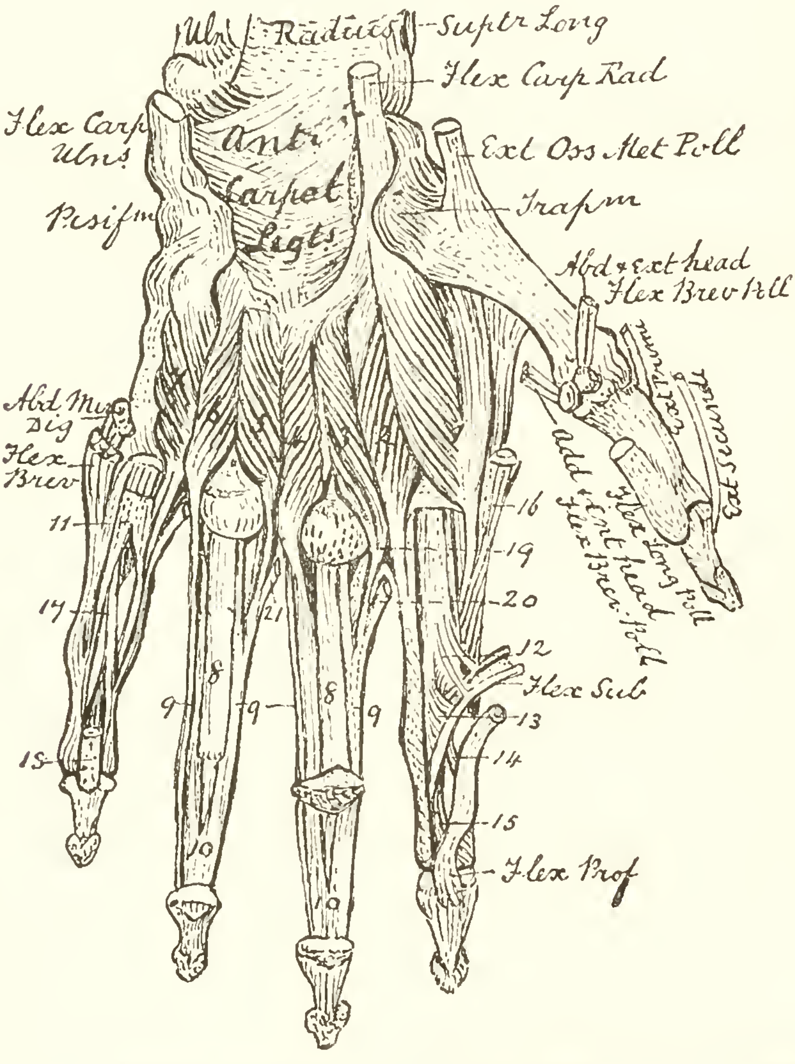


FIG. 167.—DEEP DISSECTION, SHOWING THE FLEXOR TENDONS OF THE FINGERS AND THEIR ACCESSORY PROCESSES.

The first and second phalanges of the middle and ring fingers have been removed, except the base of the second phalanx of the middle finger.

1. First dorsal interosseous.
2. First palmar ,,
3. Second dorsal ,,
4. Third ,, ,,
5. Second palmar ,,
6. Fourth dorsal ,,
7. Third palmar ,,
8–8. Middle part of ext. com.
9, 9, 9. Lateral parts of ext. com.
10, 10. Union of the lateral parts of ext. com.
11. Flex. sub.
12. Vincula accessoria of flex. sub.
13. Lig. breve of flex. sub.
14. Vincula accessoria of flex. prof.
15. Lig. breve of flex. prof.
16. First lumbrical.
17. Interlacement of its fibres before splitting.
18. Insertion of flex. prof.
19. Expansion from second dorsal intoss. to corresponding extensor.
20. Tendon of second lumbrical joining that of second dorsal, and both becoming continuous with the lateral portions of ext. com.
21. Tendon of third lumbrical joining that of second palmar intoss., and both joining inner lateral part of ext. com. The opened flexor sheath is shown just above 11.

annular ligament the tendons of the sublimis are superficial to those of the profundus, and instead of being arranged in pairs, as in the forearm, all four are nearly on the same level. As they pass onwards they diverge, and opposite the middle of the first phalanges each tendon divides, leaving a fissured space, between which one of the tendons of the flexor profundus passes. Then the tendons of both sublime and deep flexors enter the osseo-aponeurotic digital sheath, the tendon of the profundus being concealed by that of the sublimis. The tendons of the sublimis having transmitted those of the profundus, expand a little to form a grooved channel for the accompanying deep flexor tendon, and are re-united by their margins behind it. The two divisions then unite, and divide a *second* time, to be *inserted* by two processes into the sides and forepart of the second phalanges, about their middle.

Directions.—Cut through the tendons of the flexor sublimis just above the wrist, and throw them towards the fingers. Remove the connective tissue from the tendons of the deep flexor, and from the lumbricales muscles between its tendons.

The **Tendons of the Flexor Profundus Digitorum.**—It will be recollected that in the forearm the tendon of this muscle for the index finger was distinct, but at the lower border of the annular ligament there are four distinct tendons which diverge, and pass through the slips in the tendons of the flexor sublimis to be *inserted* into the bases of the last phalanges, where they are a little expanded. Between the tendons of the deep flexor the lumbricales muscles arise. Between the tendons of both flexors and the phalanges are the small *ligamenta brevia*, which have already been described. There is one for each tendon to connect it with the capsule of the interphalangeal joint, and with the anterior part of the phalanx just behind the bone into which it is inserted. The ligament fixing the profundus is anterior to but smaller than that for the sublimis.

The **Lumbricales Muscles** are four small fleshy fasciculi, accessory to the flexor profundus. They *arise* by fleshy fibres from the tendon of the profundus near the annular ligament. The *first* and *second* take origin from the radial side and palmar surface of the tendons for the middle and index fingers; the *third* from the contiguous sides of the tendons of the middle and ring fingers; and the *fourth* from the adjoining sides of the tendon of the ring and middle fingers. They pass to the radial sides of the corresponding digits, and opposite the metacarpo-phalangeal joint each tendon ends in a broad aponeurosis, which is inserted into the tendinous expansion of the extensor communis digitorum, in front of the corresponding interosseous muscle. This expansion covers the dorsal aspect of the first or metacarpal phalanx.

Relations.—They are subcutaneous between the processes of the palmar fascia, but in the middle of the palm they are covered by the various structures which have already been reflected in this dissection. *Beneath* them are the deep arch and interosseous vessels and muscles, and deep branches of the ulnar nerve. It will be noticed that the outer two arise from *single* tendons, but the inner two are connected *each* with two tendons.

Actions.—They flex the first phalanges, and acting with the flexors of the fingers they can bend the metacarpo-phalangeal joints, when the two last joints of the digits are kept straight by the extensor. Hunter,

and latterly Cleland, say that these and the dorsal interossei flex the first phalanges and extend the last two, and this view is supported by Prof. Allan Thomson in the last edition of Quain's 'Anatomy.'

Nerves.—The two *outer* lumbricales are supplied by the median; the two *inner* by the ulnar nerve.

Varieties.—These frequently occur. Sometimes there are only three, the fourth being absent, and in rare cases there are five or six. One finger (most frequently the third or fourth) has sometimes two inserted into it, or one muscle may be inserted into two fingers. The fourth has been noticed to supply the place of the fourth tendon of the flexor profundus. The first may arise from the tendon of the flexor longus pollicis or from a supplementary muscle of the forearm. The second may have two heads of origin. The third and fourth may have only one head of origin, instead of two from the radial side of the tendons for the third and fourth fingers. It is rare to see them inserted into the ulnar side of the phalanx. The first and second may both be inserted into the first phalanx of the middle finger.

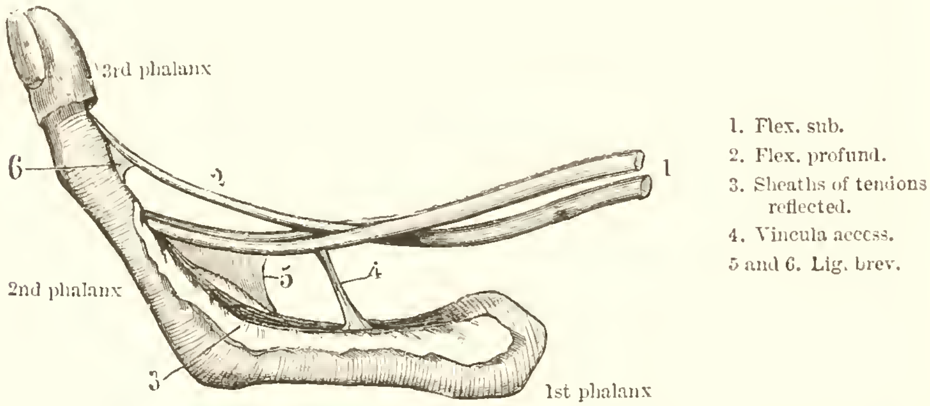


FIG 168.—FLEXOR TENDONS AND THEIR ATTACHMENTS AND PROCESSES.

Tendon of the Flexor Longus Pollicis.—This, after escaping from the annular ligament, passes out between the heads of the flexor brevis pollicis, and is inserted into the base of the last phalanx of the thumb. The common synovial membrane surrounds it beneath the annular ligament, and commonly sends a prolongation into its digital sheath.

Dissection.—Cut through the tendons of the flexor profundus above the wrist, and throw them, with the lumbricales, towards the fingers, being careful of two slender vessels and nerves entering the two inner lumbricales. The deep palmar arch, the deep branch of the ulnar nerve, and the palmar interossei muscles will be exposed. The muscles of the thumb and little finger are to be cleaned and defined.

Muscles of the Thumb.—Of the four short muscles comprising this group, the most superficial is the abductor pollicis; beneath it is the opponens pollicis, and to the inner side of the latter is the flexor brevis pollicis. The adductor pollicis passes from the middle metacarpal bone to the first phalanx of the thumb.

The **Abductor Pollicis** is a thin flat muscle about an inch wide, and is immediately beneath the skin. It *arises* from the radial side and upper

part of the anterior annular ligament, and from the ridge of the os trapezium, and passes down and out to be *inserted* by a flat thin tendon into the outer or radial side of the base of the first phalanx of the thumb.

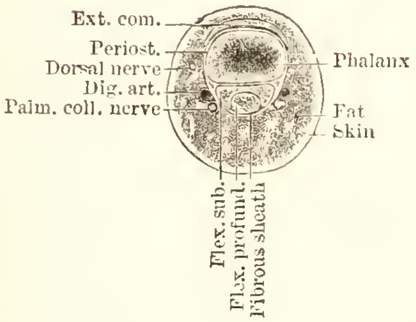


FIG. 169.—VERTICAL TRANSVERSE SECTION OF FINGER THROUGH MIDDLE OF SECOND PHALANX.

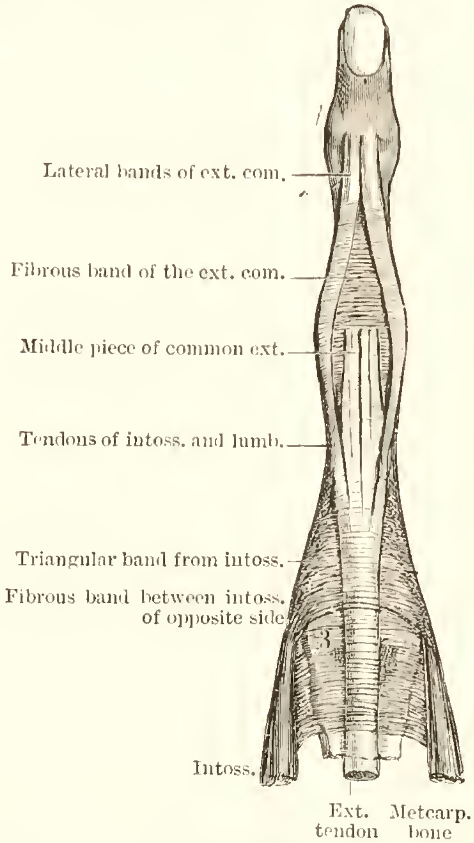


FIG. 170.—DORSAL ASPECT OF A FINGER SHOWING ARRANGEMENT OF TENDONS.

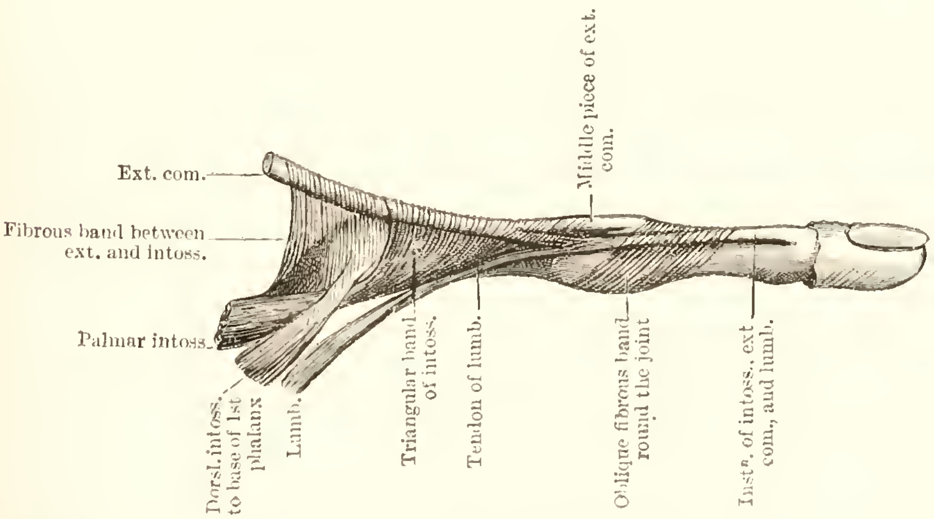


FIG. 171.—LATERAL VIEW OF A FINGER, THE EXTENSOR TENDON RAISED.

Relations.—Superficially with the palmar fascia; *deeply*, with the opponens pollicis, being separated from it by a thin aponeurosis; *inside*, it is separated by a narrow interval from the flexor brevis pollicis, and it

is often connected at its origin with a slip from the extensor ossis metacarpi tendon.

Action.—It draws the metacarpal bone of the thumb outwards, i.e. from the other digits; and this being done it may aid the flexor brevis pollicis in flexing the metacarpo-phalangeal articulation.

Nerve.—The median.

Varieties.—It is frequently divided into an outer and inner part which Soemmerring considered as normal. It sometimes has accessory slips from the opponens pollicis, or from the styloid process of the radius.

Dissection.—Divide the abductor about its middle and reflect it. A slight cellular interval will be found between the inner border of this muscle and the flexor brevis, which will be a guide to the point of sepa-

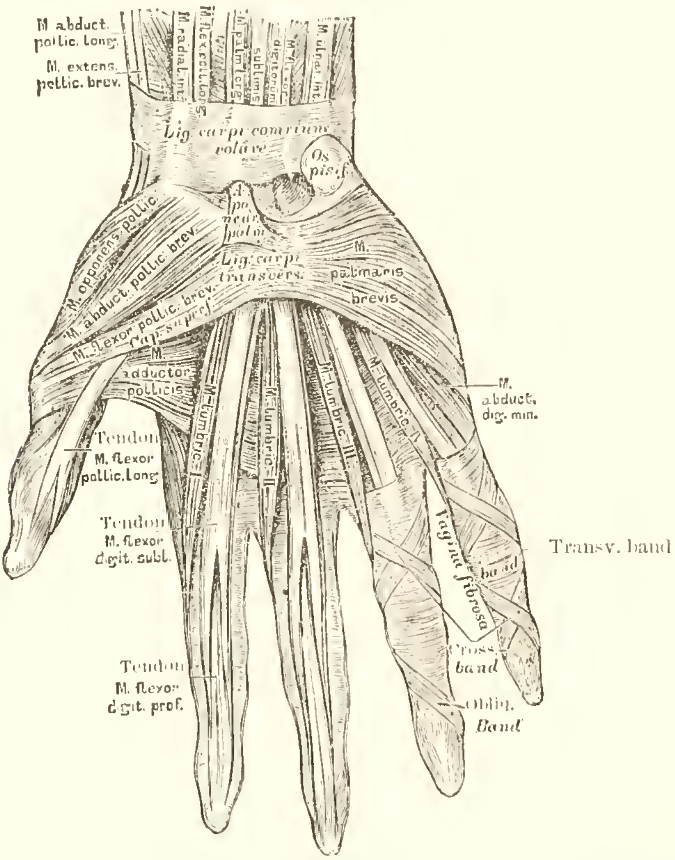


FIG. 172.—MUSCLES AND TENDONS OF THE RIGHT PALM. SUPERFICIAL DISSECTION.

ration between them. The opponens and flexor brevis will now be exposed.

The **Opponens Pollicis** is a small triangular muscle placed beneath and partly above the preceding. It *arises* from the palmar surface of the trapezium, from its ridge, and from the annular ligament, and passes down and out to be *inserted* into the whole length of the metacarpal bone of the thumb at its radial border, and partly into its anterior aspect.

Relations.—*Superficially*, with the abductor pollicis; *deeply*, with the trapezio-metacarpal joint; *inside*, with the flexor brevis pollicis; and *outside* is the abductor pollicis.

Action.—It draws the metacarpal bone of the thumb towards the palm,

and turns it so that the ball of the thumb can be applied to the ball of each of the fingers.

Nerve.—The median.

Varieties.—It may be smaller or larger than usual, and may be more or less blended, or more distinctly separated than usual from the neighbouring muscles. It may be inserted into the external sesamoid bone of the thumb.

The **Flexor Brevis Pollicis** is the largest of this group, and consists of

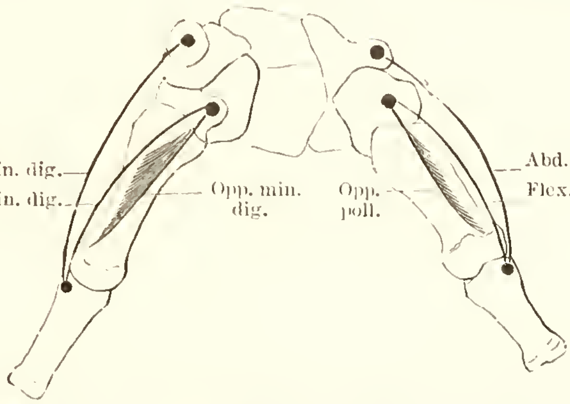


FIG. 173.—DIAGRAM OF THE ATTACHMENTS OF THE THUMB AND LITTLE FINGER MUSCLES OF LEFT HAND.

two portions at its origins which are anterior and posterior, and which transmit the tendon of the longus pollicis.

The *Anterior Outer* or *more Superficial* part arises from the palmar surface of the trapezium, and outer two-thirds of the annular ligament at its lower part.

The *Posterior Inner* or *Deeper Portion* arises from the palmar surface of the trapezoid, os magnum, bases of the second and third metacarpal bones, and sheath of the tendon of the flexor carpi radialis. The fleshy

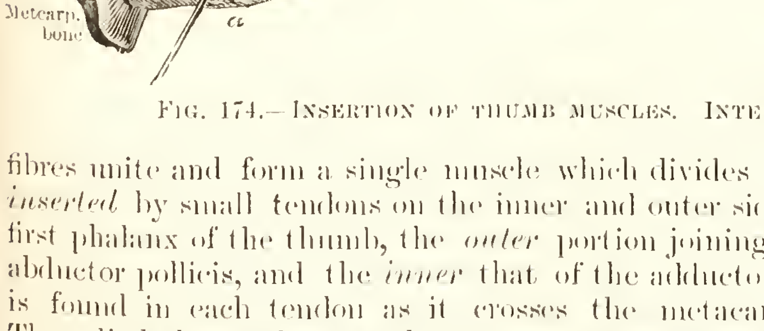


FIG. 174.—INSERTION OF THUMB MUSCLES. INTERNAL VIEW.

fibres unite and form a single muscle which divides into two pieces to be *inserted* by small tendons on the inner and outer sides of the base of the first phalanx of the thumb, the *outer* portion joining the insertion of the abductor pollicis, and the *inner* that of the adductor. A *sesamoid* bone is found in each tendon as it crosses the metacarpo-phalangeal joint. These little bones play over the grooved surface of the first metacarpal bone. The outer head of origin is joined by a strong fasciculus from the inner head.

Action.—It flexes the metacarpo-phalangeal joint of the thumb, and assists the opponens in drawing the thumb inwards and forwards towards the palm.

Relations.—Superficially, with the fasciæ; *deeply*, with the adductor pollicis and tendon of the flexor carpi radialis; *externally*, with the

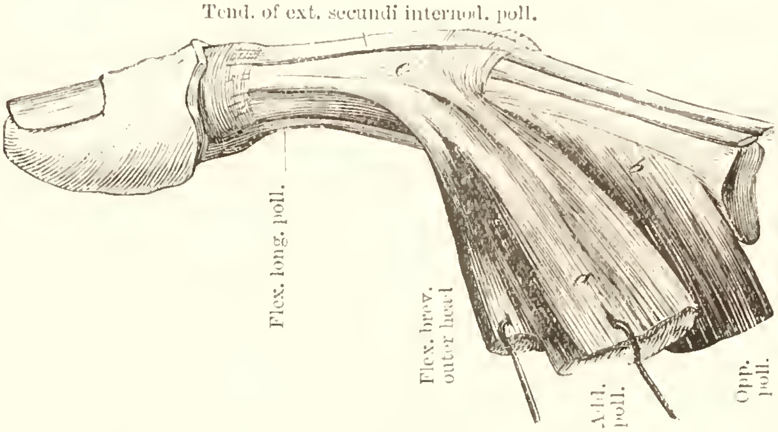


FIG. 175.—INSERTION OF THUMB MUSCLES. OUTSIDE VIEW.

e. Aponeurotic expansion from abductor pollicis to the tendon of ext. secundi.

opponens pollicis; *internally*, with the tendon of the flexor longus pollicis. The radial artery issues from beneath its *inner* head.

Nerve.—The *outer* head is supplied by the median nerve, and the *inner* head by the ulnar.

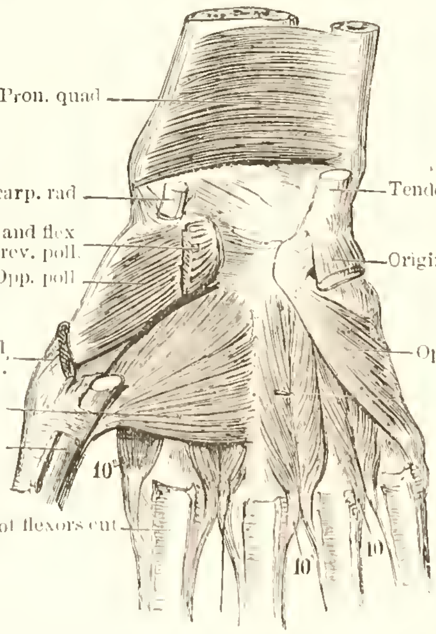


FIG. 176.—DEEP MUSCLES OF RIGHT HAND.

Varieties.—It is subject to variation especially with regard to its deeper head of origin, a part of which may be more or less connected with the adductor pollicis.

The **Adductor Pollicis** is the deepest of this group, and is triangular at its base, and *arises* from the lower two-thirds of the palmar aspect of the

metacarpal bone of the middle finger, and the fibres pass out and converge to be *inserted* with the inner tendon of the flexor brevis pollicis into the ulnar side of the base of the first phalanx of the thumb, and into the inner sesamoid bone.

Relations.—Superficially, with the flexor brevis pollicis, and the tendons of the flexor profundus, and lumbricales; *deeply*, with the first dorsal interosseous and the second and third metacarpal bones, and corresponding palmar interosseous muscles, from which it is separated by a strong aponeurosis. Its *upper* border is in relation with the deep head of the flexor brevis.

Action.—It approximates the thumb to the fingers, and applies it to the radial border of the hand.

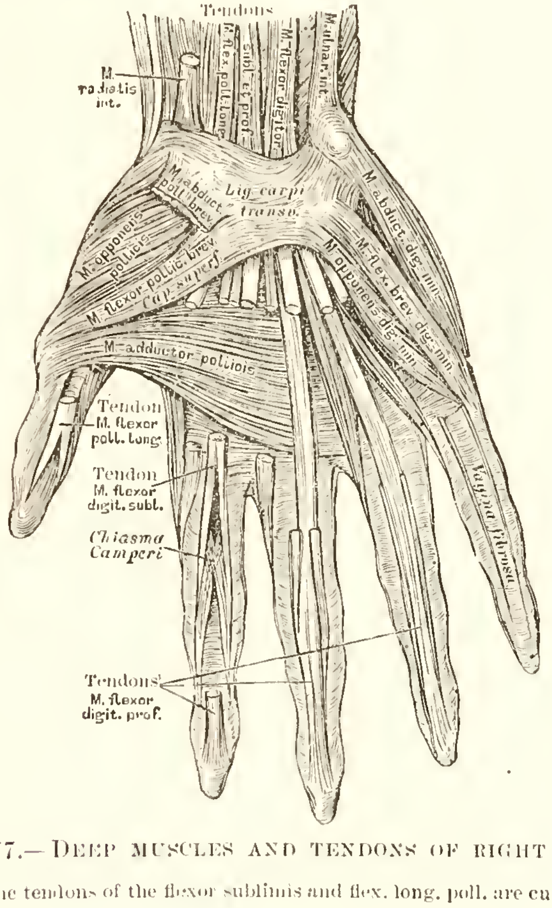


FIG. 177.—DEEP MUSCLES AND TENDONS OF RIGHT HAND.

The tendons of the flexor sublimis and flex. long. poll. are cut.

Nerve.—The ulnar.

Varieties.—It may vary in its extent of origin in inverse proportion to that of the flexor brevis pollicis.

Muscles of the Little Finger.—The palmaris brevis having already been removed, the three short muscles of this region will now have to be cleaned and defined.

The **Abductor Minimi Digiti** is the most internal, and arises by tendinous fibres from the pisiform bone and from an expansion of the tendon of the flexor carpi ulnaris, and is *inserted* by a flat tendon into the ulnar side of the base of the first phalanx of the little finger, sending an offset to the extensor tendon on the back of the phalanx.

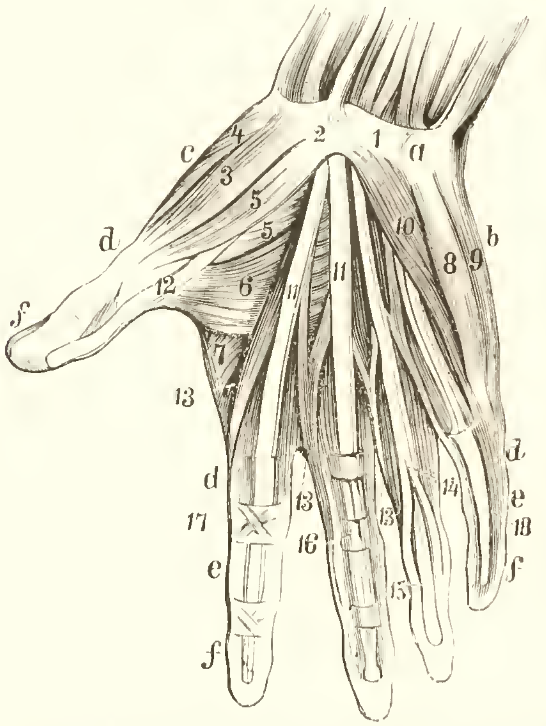
Relations.—*Superficially*, with the inner piece of the palmar fascia, and the palmaris brevis; *deeply*, with the flexor ossis metacarpi; *outside*, with the flexor brevis minimi digiti.

Action.—It removes the middle finger from the rest, and can then flex the metacarpo-phalangeal joint.

Nerve.—The ulnar.

Varieties.—It is sometimes partly divided into two or three slips, and is occasionally united with the flexor brevis.

The **Flexor Brevis Minimi Digiti** is on the same plane as the preceding muscle, but at its radial side, and is separated at its origin from the abductor muscle by a small interval through which the deep branch of the ulnar nerve and artery pass into the palm. It *arises* from the tip of the



1. Ant. ann. lig.
2. Insertion of palm. long.
3. Abd. poll.
4. Opp. poll.
5, 5. Flex. brev. poll.
6. Add. poll.
7. Abd. indicis.
8. Abd. min. dig.
9. Oppns. min. dig.
10. Flex. brev. min. dig.
11. Tendons of flex. subs. and profds.
12. Tend. flex. long. poll.
13. Lumbricales.
14. Splitting of subls. tendon.
15. Tendon of profds.
16. Annular or transverse ligts.
17. Crucial bands or ligaments.
18. Vaginal ligament of tendons.

FIG. 178.—SHOWING THE FLEXOR TENDONS, THE PALMAR INTEROSSEI, AND A DIFFERENT DISSECTION ON EACH FINGER.

a. Pisiform. *b, c.* Line of carpo-phalangeal joints. *d d.* First phalanges. *e e.* Second phalanges. *f f.* Third phalanges.

unciform process of the unciform, and slightly from the front of the annular ligament, and is inserted by a thin tendon into the base of the first phalanx of the little finger in connection with the abductor pollicis.

Relations.—*Superficially*, with the inner piece of the palmar fascia of the palmaris brevis; *deeply*, with the opponens, and between it and the abductor are the deep branches of the ulnar artery and nerve.

Action.—It flexes the metacarpo-phalangeal joint.

Nerve.—The ulnar.

Varieties.—It is sometimes absent, and then the abductor is large.

The **Opponens**, or **Adductor Minimi Digiti**, is placed beneath the others, and is triangular, and resembles the opponens pollicis in being attached to the shaft of the metacarpal bone. It *arises* from the unciform process

of the unciform bone and contiguous part of the annular ligament, and its fibres pass down and in, to be inserted along the ulnar margin of the metacarpal bone of the little finger along its whole length.

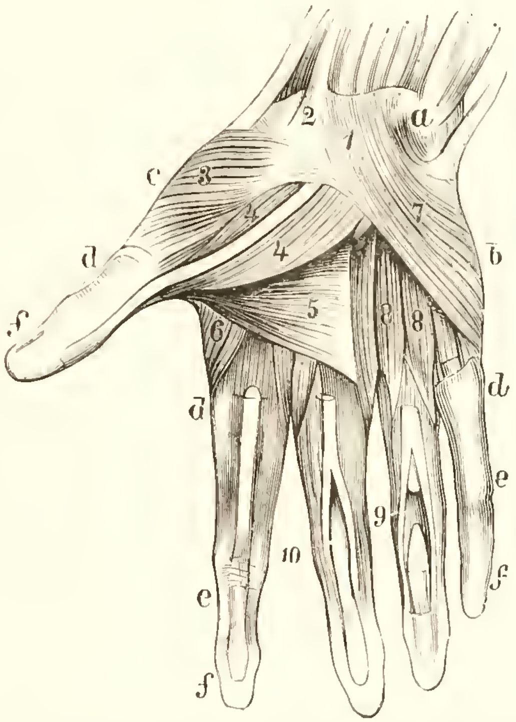
Relations.—It is *beneath* the preceding muscles, and its *deep* surface is in relation with the interossei of the fourth metacarpal space; with the fifth metacarpal bone, the flexor tendons of the little finger; the deep branches of the ulnar artery and nerve also pass beneath it.

Nerve.—The ulnar.

Action.—It raises the fifth metacarpal bone, and draws it towards the others, deepening the palm of the hand.

Varieties.—These are similar to those of the opponens pollicis.

Dissection.—Cut through the origins of the flexor brevis pollicis, and reflect it to expose the deep palmar arch and the deep branch of the



3. Opp. poll.
4. Flex. brev. poll.
5. Add. poll.
6. Abd. indicis or first dorsal intoss.
7. Opp. min. dig.
8 8. Palmar intoss.
9. Division of subls. tendon.
10. Flex. subls. tendon.

FIG. 179.—THE FLEXOR TENDONS CUT, SHOWING DEEPER MUSCLES.

a, b, c, d, e, f, as in previous figure. 1. Ant. ann. lig. 2. Insertion of palm. long. Right hand.

ulnar nerve which accompanies it, and trace out their offsets. Note the connection of the fascia or aponeurosis covering the palmar interossei with the *transverse ligament* joining the heads of the metacarpal bones.

The **Radial Artery in the Hand.**—This vessel enters the palm between the first two metacarpals at the first interosseous space, passing between the heads of the first dorsal interosseous muscle, or abductor indicis. It then transversely crosses the palm, to reach the base of the metacarpal bone of the little finger, where it joins the communicating branch from the ulnar artery to form the deep palmar arch. It is accompanied by venæ comites.

The **Deep Palmar Arch** extends from the upper end of the first interosseous space to the base of the fifth metacarpal bone. Its convexity is

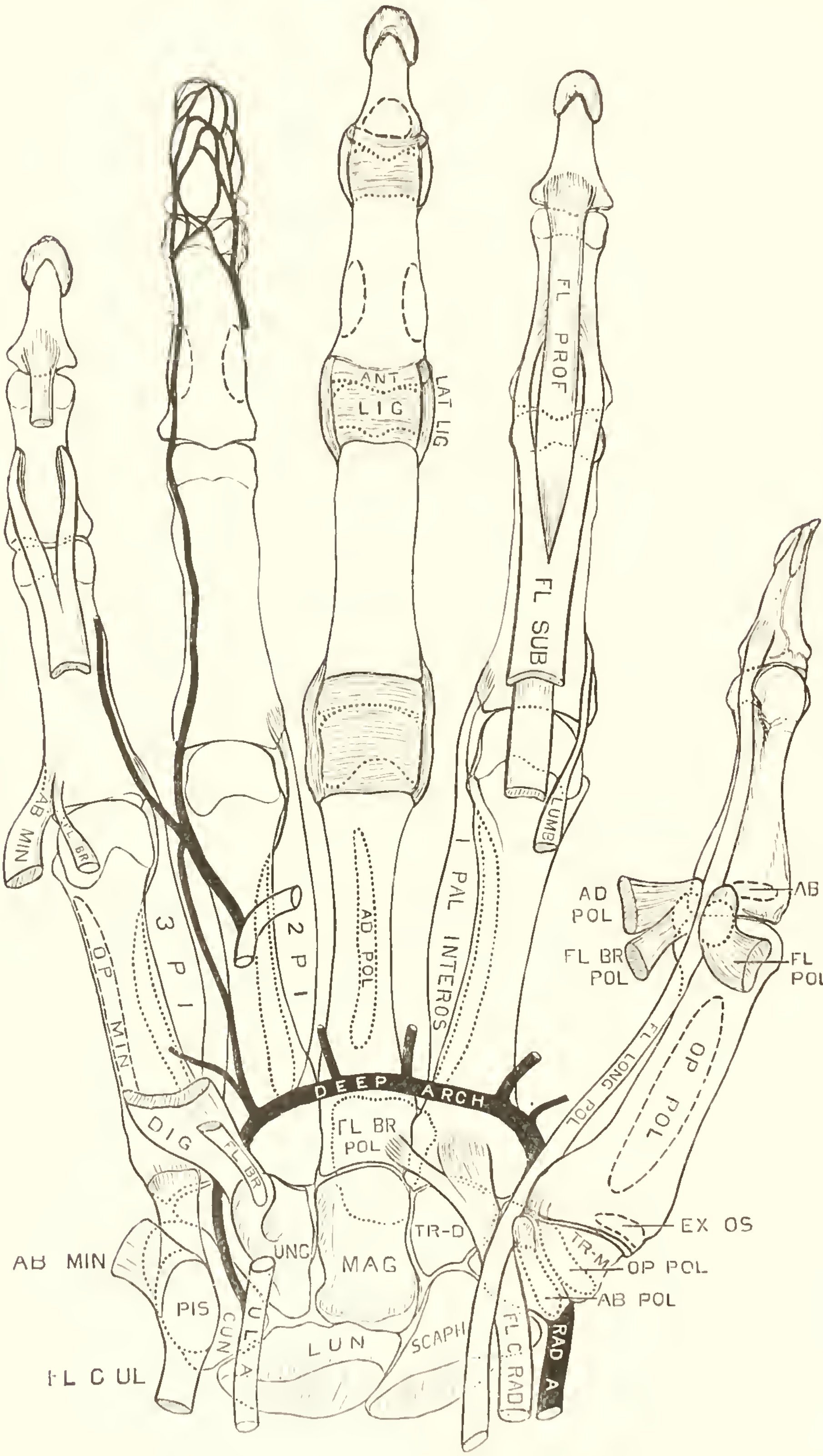


FIG. 180.—PALMAR ASPECT OF RIGHT HAND.

Outline diagram from Cossar Ewart. Part of the superficial arch giving off digitals is seen on the ring finger.

directed forwards, and it is higher up and more posterior, i.e. nearer the carpal bones, than the superficial arch. It is deeply placed, resting upon the carpal ends of the metacarpal bones and the interossei muscles, and is covered by the long flexor tendons of the fingers, the lumbricales, the muscles of the little finger, and partly by the flexor brevis pollicis.

The *Branches of the Deep Arch* are the princeps pollicis, radialis indicis, recurrent, perforating and interosseous.

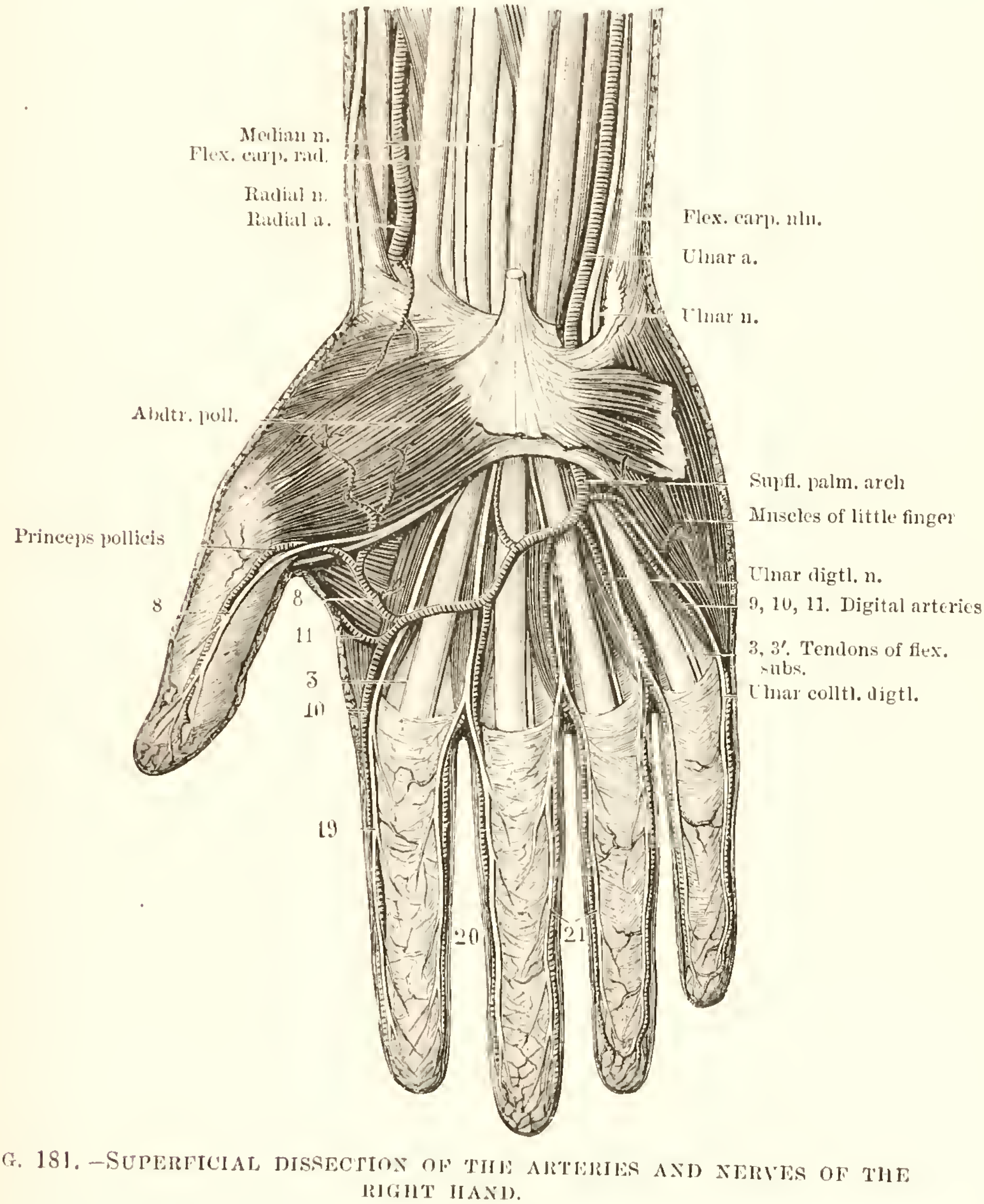


FIG. 181.—SUPERFICIAL DISSECTION OF THE ARTERIES AND NERVES OF THE RIGHT HAND.

8, 19, 20, and 21 are the palmar collateral digitals. The tendon of the palmaris longus, the palmaris brevis, and the palmar fascia are cut.

Digital Branches of the Radial.—These are the princeps pollicis and radialis indicis.

The *Princeps Pollicis* is given off just as the radial turns to the deep part of the palm. It passes along the inner side of the metacarpal bone of the thumb, between this and the flexor brevis pollicis, and between the

abductor pollicis and first dorsal interosseous, to the base of the first phalanx, where it divides into the two collateral branches of the thumb. These run along the sides of its palmar aspect, and form an arch on the under-surface of the last phalanx, from which branches supply the skin and cellular tissue of the thumb and anastomose with the dorsales pollicis.

The *Radialis Indicis* arises close to the preceding, passing over the first dorsal interosseous muscle, and between it and the adductor pollicis, and beneath the flexor brevis, to the radial side of the index finger as far as its end, where it joins the digital branch of the superficial palmar arch.

1. Radial a.
2. Sup. volæ (cut).
3. Dorsal continuation of radial.
4. Princeps pollicis.
5. Ulnar a.
6. Digitals to inside of little finger.
7. Deep arch.
8. Intoss. a.
9. Digitals (cut).
10 and 11. Collatl. digitals.

FIG. 182.—LEFT DEEP PALMAR ARCH AND ITS BRANCHES AND ANASTOMOSES.

The supfl. arch is cut, and only the deepest muscles are shown. The anastomoses on the digits and between the carpals of radial and ulnar, and the recurrents of the deep arch, are depicted. The first dorsal and three palmar interossei, the abductor and flexor brevis min. dig. are shown.

It is usually connected at the free or anterior border of the adductor pollicis with the superficial palmar arch and with the princeps pollicis.

Recurrent Branches go from the convexity of the arch, and anastomose with the anterior carpals of the radial and ulnar arteries, and supply the carpal bones and joints.

The *Perforating Arteries* are three; they pass between the heads of the three inner dorsal interossei, and anastomose with the dorsal interosseous arteries.

The *Palmar Interosseous* are usually three, but there may be four. They lie in the three inner metacarpal spaces running forwards on the corresponding interossei muscles, which they supply, as well as the two or

three inner lumbricales. At the clefts of the fingers they anastomose with the digital branches of the superficial arch. These vessels vary much in their size and distribution.

The *Deep Palmar Branch of the Ulnar Nerve* accompanies the deep arch, and passes between the abductor and flexor brevis minimi digiti. At its origin it gives twigs to the muscles of the little finger, and as it crosses the hand it sends two branches to each interosseous space—one for the palmar, and the other for the dorsal interosseous muscle. The filaments to the second and third palmar interossei send twigs to the two inner lumbricales. Near its termination, between the thumb and index finger, it supplies the *inner* head of the flexor brevis and the adductor pollicis. It has similar relations to those of the deep arch.

The *Transverse Metacarpal Ligament* is a narrow fibrous band con-

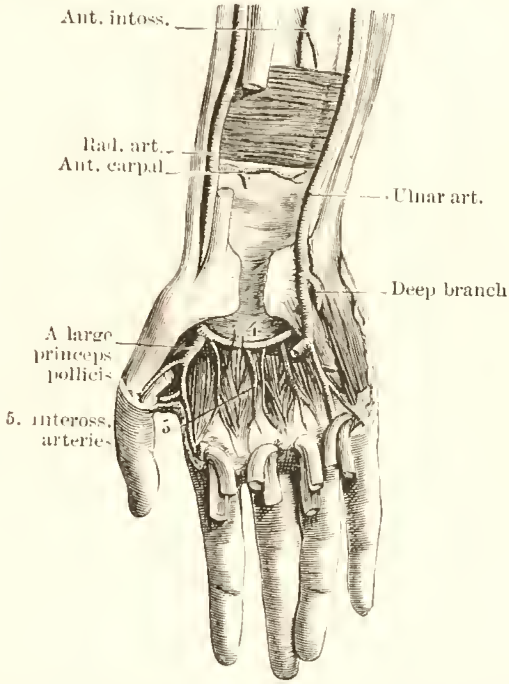


FIG. 183.—DEEP PALMAR ARCH. RIGHT SIDE.

The tendon of the flex. carp. rad. is cut.

necting the heads of the four inner metacarpal bones. It passes transversely across their anterior surface, and blends with the ligaments of the metacarpo-phalangeal joints. Its anterior aspect has four grooves for the flexor tendons, and its posterior surface blends with the ligaments of the metacarpo-phalangeal joints, and beneath it the interossei pass to their insertion. Its anterior border is free, but its posterior is connected with the fascia covering the interossei muscles.

Dissection.—This ligament must be divided and reflected from between the spaces, in order to see the mode of insertion of the interossei.

The **Palmar Interossei** are three in number. They are smaller than the dorsal, and are situated on the palmar surface of the metacarpal bones, rather than beneath them. They *arise* from the whole length of the hollow lateral part of the shaft of the metacarpal bone of the fingers, on which they act, and are *inserted* by tendons into the side of the base of

the first phalanges of the corresponding fingers, and also into the common extensor expansion of the same finger.

The *First Palmar Interosseous* arises from the *ulnar* side of the metacarpal and index finger, and is inserted into the same side of the base of the first phalanx of that finger.

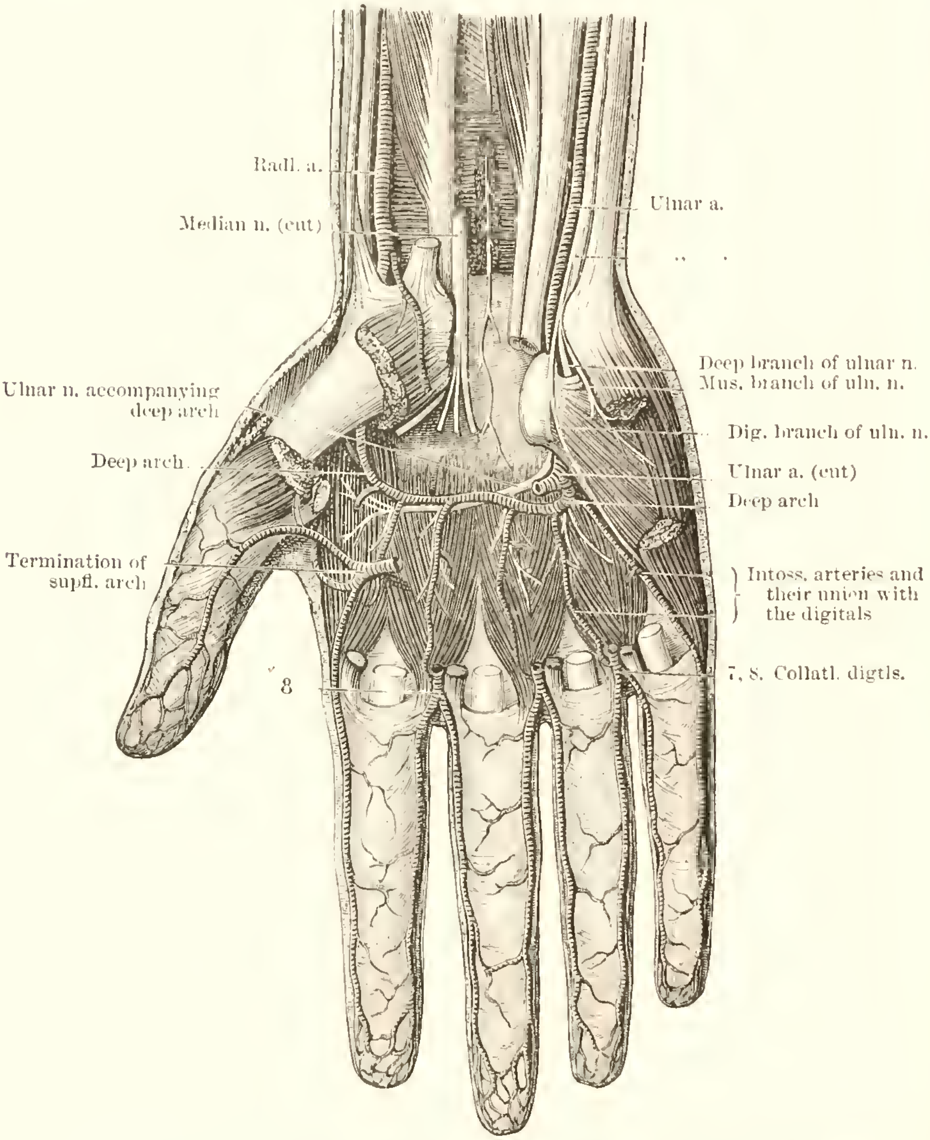


FIG. 184.—THE DEEP ARCH AND BRANCHES, AND DEEP NERVES AND MUSCLES. RIGHT SIDE.

The anastomoses of the collateral digitals on the tendinous sheaths are shown. The tendons of the flexor carp. radialis and flexors sublimis and profds. are cut and removed, and some of the muscles of the thumb and little finger are also cut.

The *second* arises from the *radial* side of the fourth metacarpal, and is inserted into the same side of the base of the first phalanx of that finger.

The *third* takes origin from the *radial* side of the fifth metacarpal, and is inserted into the same side of the little finger.

The student will observe that each finger has two interossei muscles,

the little finger being excepted. This digit has no dorsal interosseous (which is an abductor), because it possesses a special abductor muscle—the abductor minimi digiti.

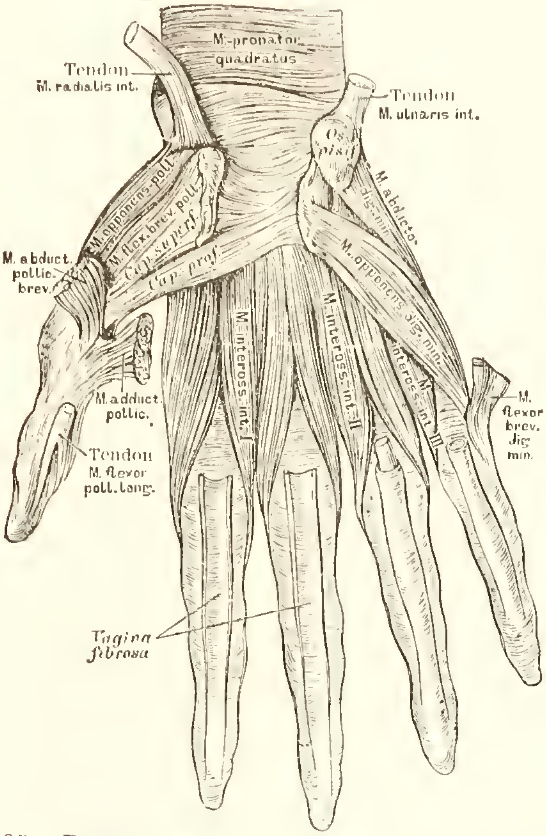


Fig. 185.—Deepest muscular layer of right hand.

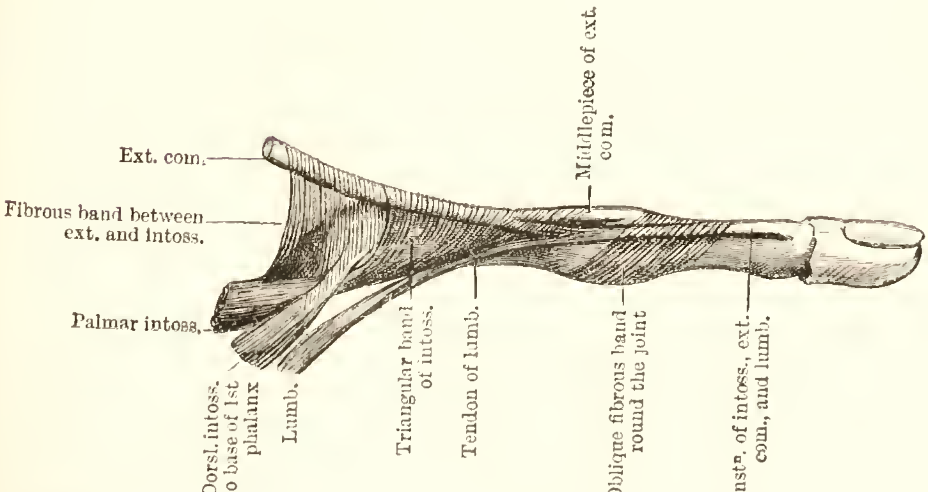


Fig. 186.—Lateral view of a finger, the extensor tendon raised.

The index finger	has	1 palmar	and	1 dorsal		
„ middle	„	no	„	2	„	interossei
„ ring	„	1	„	1	„	
„ little	„	1	„	no	„	

The reason of this arrangement will be better understood in considering the action of these muscles.

Actions.—The palmar interossei are all adductors to the middle finger. It has been previously shown that the dorsal muscles were abductors from the same point. The middle finger has no palmar interosseous because it is the midline, and therefore cannot be drawn any nearer to that point but as the other three digits can be approximated to the middle fingers

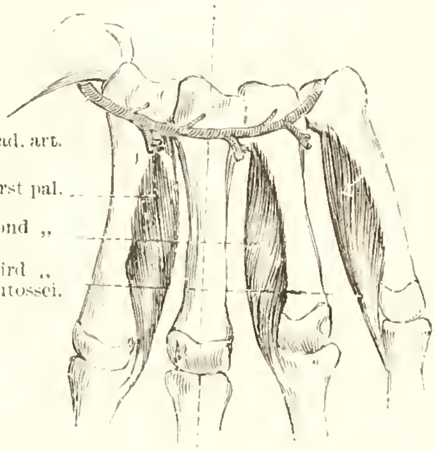


FIG. 187.—DEEP PALMAR ARCH AND PALMAR INTEROSSEI.

The anastomoses of the perforating arteries with the dorsal interossei near the upper part of the intoss. spaces is shown. The dotted line through the middle finger is to make plainer the action of the palmar interossei and adductors towards it.

they have special palmar adductors. The thumb of course does not need an interosseous adductor, as it has a special one, but the little finger not being provided with a special adductor needs, and is furnished with, a palmar interosseous adductor.

Nerve.—The ulnar nerve.

Varieties.—They may be double in one or more of the spaces, and

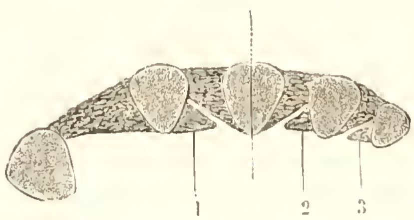


FIG. 188.—TRANSVERSE VERTICAL SECTION OF METACARPALS AND INTEROSSEI OF LEFT HAND (UPPER PART OF SECTION).

The numbers indicate the palmar interossei; the dorsal are not numbered.

rarely there is a palmar interosseous in the first space. The usual arrangement of the palmar interossei of the foot, which is peculiar to man, has also been noticed to occur in the hand, i.e. the three palmar interossei may be connected with the three inner metacarpal bones.

Dissection.—Remove the small muscles of the thumb and little finger from the annular ligament, place its cut ends together, and subsequently

dissect out its attachments; and when these have been made out, trace the tendon of the flexor carpi radialis to its insertion, and also an expansion from the flexor carpi ulnaris to the base of the fifth metacarpal bone.

The *Anterior Annular Ligament* is a strong fibrous band which arches over the carpus, and converts the deep groove on the anterior aspect of the carpal bones into a canal, beneath which the flexor tendons of the fingers pass into the palm. It serves to bind down these tendons and prevent their being dislocated in the various and complicated motions of the hand and fingers. It is continuous above with the deep fascia of the forearm, and receives some fibres from the tendon of the flexor carpi ulnaris; the lower margin is connected with the palmar fascia and gives origin to most of the short muscles of the thumb and little finger. The palmaris longus is partly attached to its upper and inner part, and it is crossed by the palmaris longus, the ulnar vessels and nerve, and the palmar cutaneous filaments of the median and ulnar nerves, and a twig of the musculo-cutaneous.

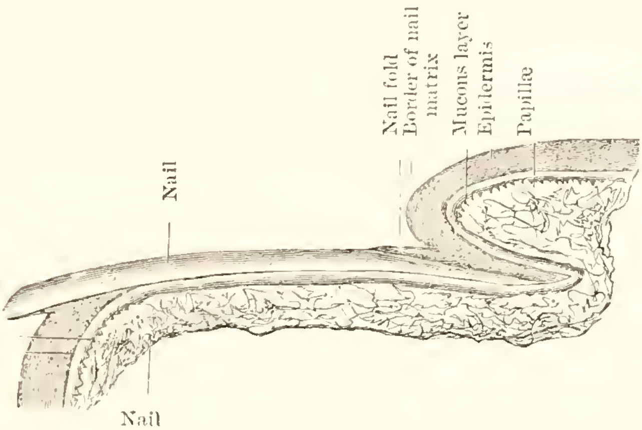


FIG. 189.—LONGITUDINAL SECTION THROUGH A NAIL AND ITS BED. MAGNIFIED SIX TIMES.

It is attached *externally* to the ridge of the trapezium and the tuberosity of the scaphoid, and *internally* to the pisiform bone, and unciform process of the unciform. It is pierced by the tendon of the flexor carpi radialis, and *beneath* it the tendons of the sublime and deep flexors, the flexor longus pollicis, median nerve, and anastomotic twigs between the deep palmar and anterior carpal arches, pass. Two synovial membranes also pass beneath this ligament—a separate one for the tendon of the flexor longus pollicis, and a larger one enclosing the tendons of the flexors sublimis and profundus.

The *Tendon of the Flexor Carpi Radialis* lies in the groove of the os trapezium between the attachments of the annular ligament to that bone, but external to it. It is bound to the groove in the bone by a fibrous sheath lined by a synovial membrane, and is *inserted* into the outer side of the base of the metacarpal bone of the index finger, and sends a slip to that of the little finger.

The student should now recapitulate his knowledge and then proceed with the dissection of the ligaments of the elbow, wrist, and joints of the metacarpus and phalanges.

THE ELBOW JOINT.

Dissection.—Should the ligaments have become dry they may be moistened by being placed in water for a short time; then the muscles and tendons surrounding the joint must be removed, and the ligaments cleaned.[1]

The **Elbow Joint** is formed by the lower end of the humerus and the upper end of the ulna and radius. It is a true ginglymus, or hinge joint, in which the trochlear surface of the humerus articulates with the greater sigmoid cavity of the ulnar, and the cup-shaped depression on the radial head articulates with the radial portion of the trochlear surface or capitulum *vel* capitellum of the humerus. The articular surfaces are covered by a thin layer of cartilage, and joined by four ligaments—anterior, pos-

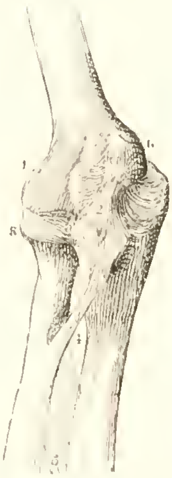


FIG. 190.—LIGAMENTS OF THE RIGHT ELBOW SEEN FROM THE INNER SIDE.

terior, external, and internal lateral. These are more or less continuous with each other, forming a kind of capsule.

The *Anterior Ligament* is a thin fibrous layer strongest at its middle, and its fibres are separated here and there by masses of fat. Above, it is attached around the upper margin of the coronoid fossa, and below to the anterior surface of the coronoid process of the ulna and orbicular ligament, being continuous at the sides with the lateral ligaments. It is composed of three sets of fibres, of which the superficial are oblique and pass from the inner condyle down and out to the orbicular ligament. The middle fibres are vertical, and extend from the upper part of the coronoid pit and blend with the preceding. The transverse set intersect the middle fibres at a right angle. It is in relation in *front* with the brachialis anticus, and *behind* with the synovial membrane.

The *Posterior Ligament* is thinner and looser than the anterior, and consists of irregular fibres, which are attached to the humerus, just above the olecranon fossa, and below to the margin of the olecranon. The upper superficial fibres pass transversely across the olecranon fossa. The deeper

[1] Before opening any joint, the student should study the state of the tendons as to tenseness and relaxation in the various movements of which the joint is capable.

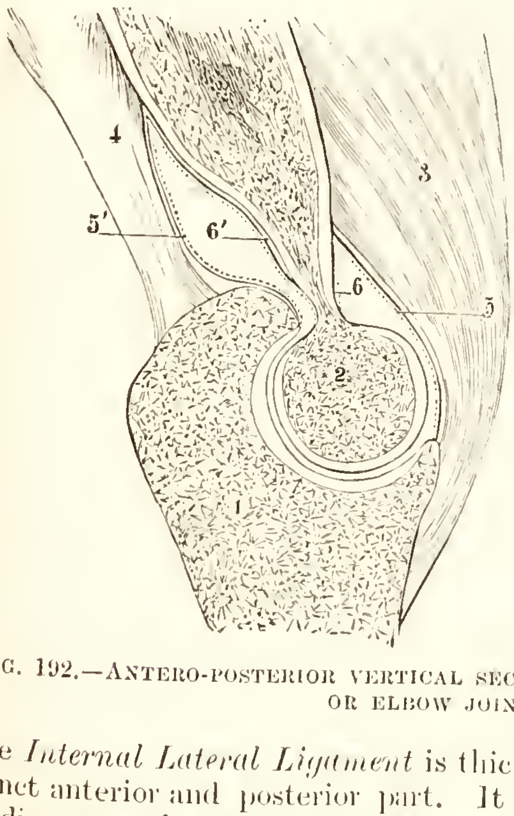
portion is made up of vertical fibres, which pass from the upper margin of the olecranon fossa to the margin of the olecranon. It is in relation in *front* with the synovial membrane, and *behind* with the triceps and anconeus.

The *External Lateral Ligament* is a short, narrow, rounded fasciculus,

1. Humerus.
2. Ulna.
3. Radius.
4. Ext. lat. lig.
5. Ant. band of ext. lat.
6. Its post. band.
7. Ant. lig.
8. Synovial memb.

FIG. 191.—RIGHT ELBOW JOINT. EXTERNAL VIEW.

less distinct than the internal, and is attached, superiorly, to the external humeral condyle, and inferiorly, to the orbicular ligament; some of its hinder fibres passing over that ligament to be inserted into the external margin of the ulna. The tendon of origin of the supinator brevis is intimately adherent with it.



1. Ulna.
2. Trochlea cut.
3. Brach. ant.
4. Tendon of triceps.
5. Dotted line of synovial memb.
5′. Synovial memb.
6 and 6′. Placed in synovial cavity.

FIG. 192.—ANTERO-POSTERIOR VERTICAL SECTION THROUGH HUMERO-ULNAR OR ELBOW JOINT.

The *Internal Lateral Ligament* is thick and triangular, and consists of a distinct anterior and posterior part. It is composed of radiating fibres which diverge as they descend. The anterior portion is attached above, by its apex, to the front of the internal condyle, and below, by its broad

base, is inserted into the inner margin of the coronoid process and greater sigmoid cavity. The posterior part is also triangular, but not so strong as the anterior. It passes from the end and back part of the inner condyle to the inner border of the olecranon. The anterior piece passes downwards and forwards and the posterior down and back. A few middle fibres join a transverse ligamentous band which crosses the notch between the olecranon and the coronoid process. It is in relation, *internally*, with the ulnar nerve, posterior ulnar recurrent artery, the triceps and flexor carpi ulnaris; and *externally*, with the synovial membrane. Small articular vessels and nerves enter the joint by openings beneath the transverse band.

Dissection.—To expose the articular surfaces, the anterior and lateral ligaments must be divided near their upper attachments and the bones

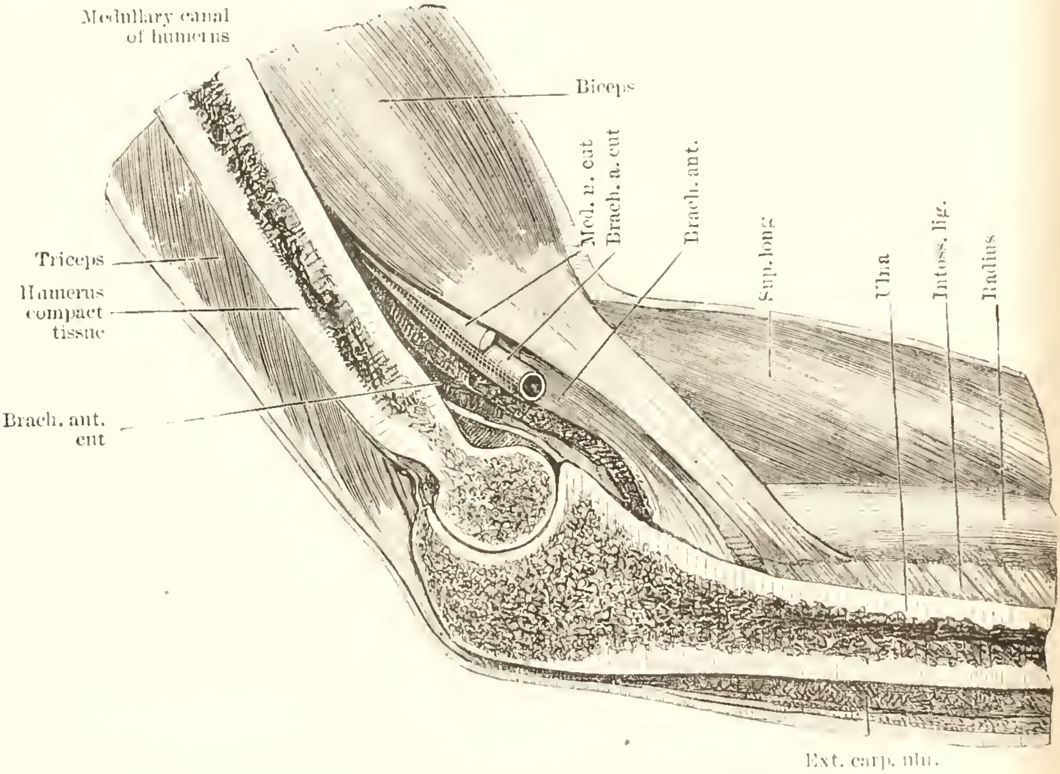


FIG. 193.—EXTERNAL PORTION OF A VERTICAL LONGITUDINAL SECTION THROUGH INNER PART OF LEFT ELBOW IN PRONATION.

The olecranon and coronoid processes with the ant. and post. ligs. and synovial cavity are shown and the section of the trochlea. The olecranon bursa is not represented.

disarticulated; but before doing this the student should make himself familiar with the use of these ligaments as given in the following paragraph.

Movements.—As already stated, this articulation is a simple hinge joint, and permits only of flexion and extension. The formation of the humeral trochlear surface with its eminences and depressions, which are arcuately fitted to the opposing surfaces of the sigmoid cavity of the ulna, prevents any great amount of lateral motion.

In *Flexion* the radius and ulna move towards the humerus and leave the posterior part of the humeral articular surface uncovered. It is checked,

partly by the posterior ligament and the hinder part of the internal lateral, but mainly by the meeting of the coronoid process with the humerus. The other ligaments are relaxed.

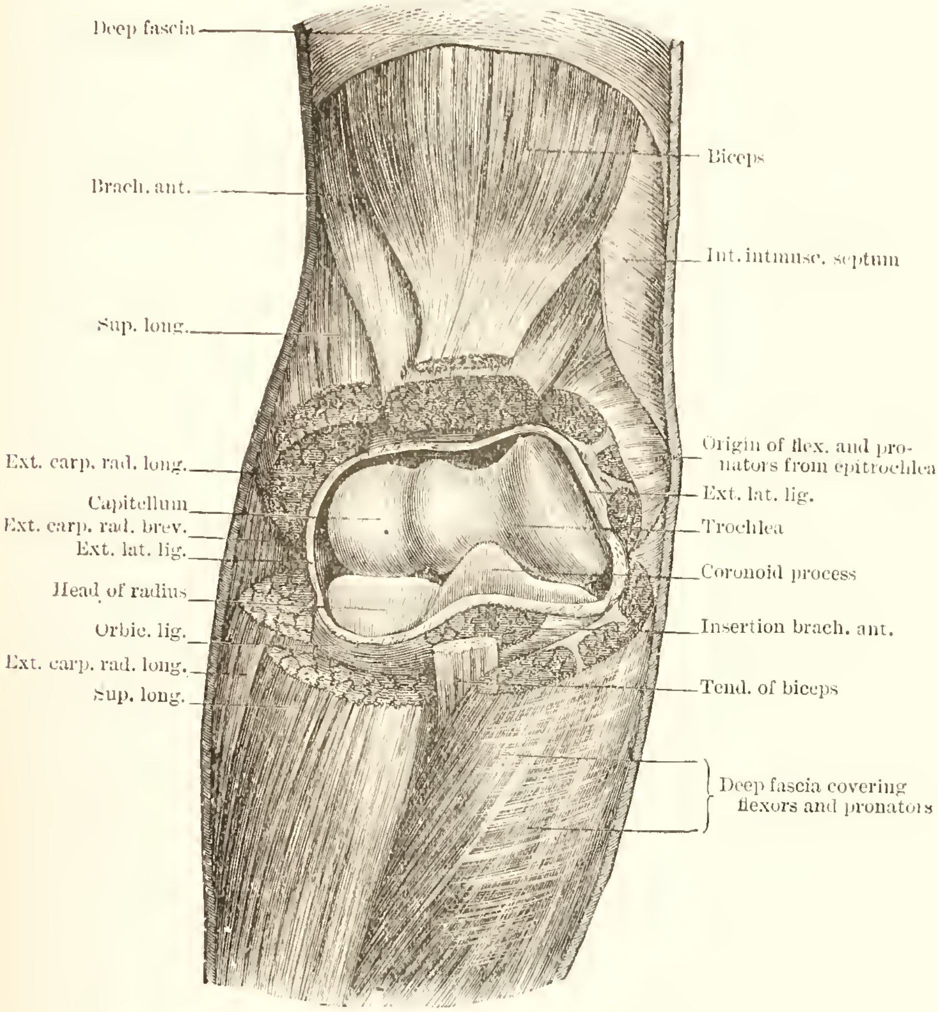


FIG. 194.—MUSCULAR RELATIONS OF RIGHT ELBOW. FRONT VIEW.

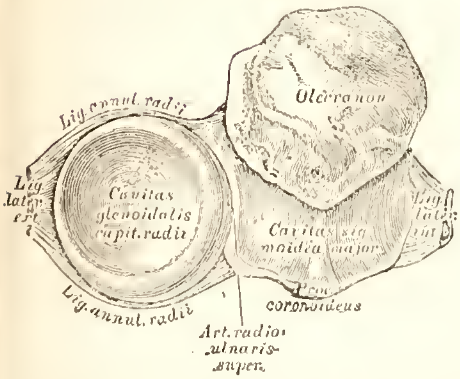


FIG. 195.—JOINT-SURFACES OF LEFT RADIUS AND ULNA, SEEN FROM ABOVE.

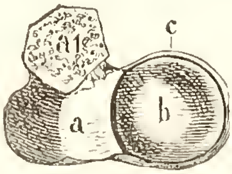


FIG. 196.—OLECRANON REMOVED FROM RIGHT ULNA. SEEN FROM ABOVE.

a. Lower part of greater sigmoid cavity. *a'*. Section through upper part of it. *b*. Cup-shaped head of radius. *c*. Orbicular ligament.

In *Extension* the forearm bones pass to the back of the humerus, each on its own articular surface, leaving the anterior portion of the humeral

articular surface uncovered. The anterior ligament and the anterior piece of the internal lateral ligament are rendered tense; but the posterior fibres

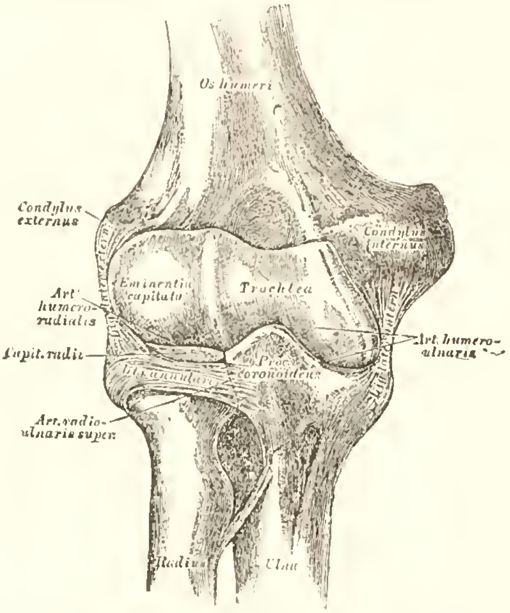


FIG. 197.—RIGHT ELBOW JOINT OPENED. ANTERIOR VIEW.

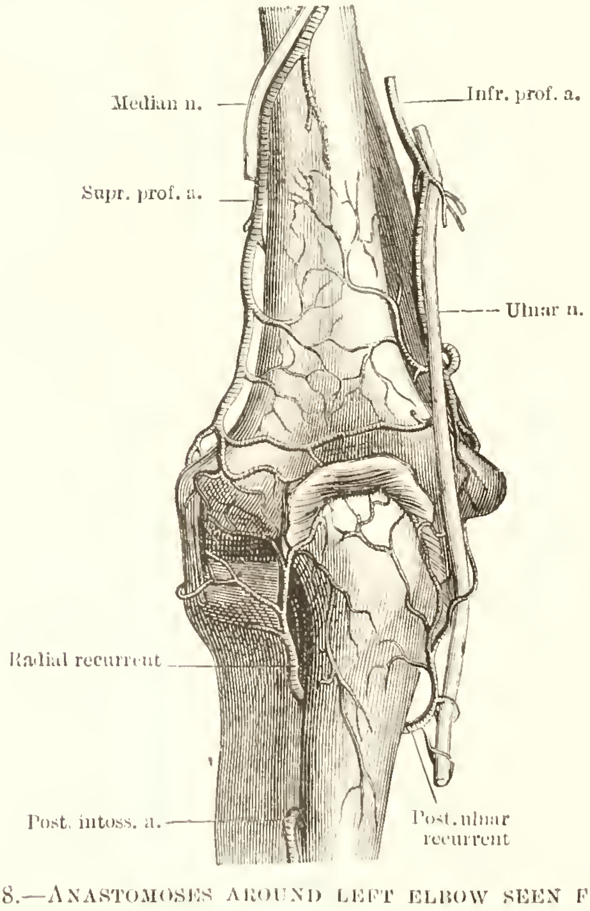


FIG. 198.—ANASTOMOSES AROUND LEFT ELBOW SEEN FROM BEHIND.

of the internal lateral are relaxed. This motion is mainly checked by the meeting of the olecranon with the back of the humerus.

The line of motion is nearly in a vertical plane, whose direction is slightly outwards, and owing to the oblique direction of the lower articular portion of the humerus, the hand falls inside the arm in complete flexion.

Directions.—The student must first follow the reflexions of the synovial membrane, and then study the articular surfaces.

The *Synovial Membrane* lines the inner surfaces of the ligaments, and passes from one bone to the other. It extends upwards on the humerus, and lines the coronoid and olecranon fossæ, being vascular and loose in these positions. Below, it is prolonged between the lesser sigmoid cavity,

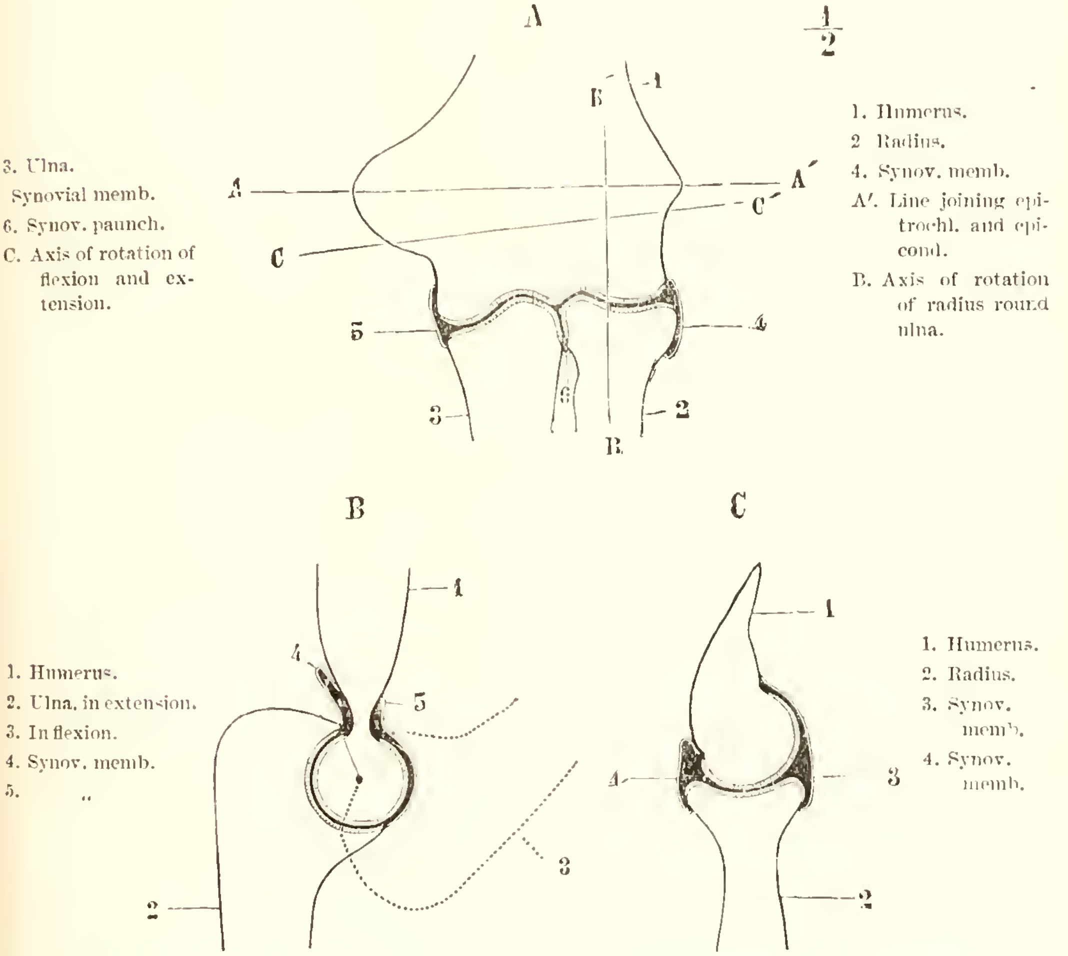


FIG. 199.

A. Front view of a transverse vertical section through left elbow. B. Vertical antero-posterior section through the trochlear and greater sigmoid cavity. C. A similar section through the radius and capitellum.

the inner surface of the orbicular ligament, and the circumference of the head and neck of the radius. It is, therefore, extensive.

Direction.—Before dividing the posterior ligament and separating the bones, the dissector should seek the vessels and nerves to the joint and be familiar with its relations.

The *Arteries to the Joint* come from the superior and inferior profundæ, anastomotic magna, recurrent radial, anterior and posterior ulnar recurrent and posterior interosseous recurrent, and form a vascular circle around the articulation.

The *Nerves* come from the ulnar as it passes between the olecranon and inner condyle, and the musculo-cutaneous also supply it.

Relations.—In *front*, the brachialis anticus; *behind*, the triceps and anconeus; *externally*, the supinator brevis and the tendon of origin of the

FIG. 200.—ATTACHMENTS OF THE DEEP POSTERIOR MUSCLES OF RIGHT FOREARM.

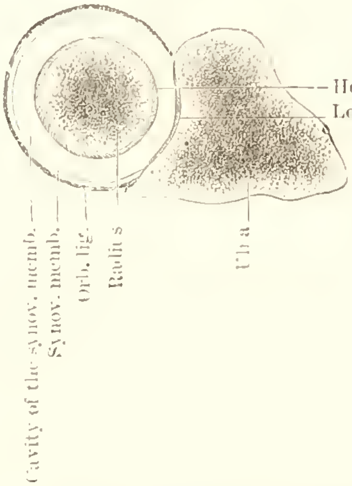


FIG. 201.—HORIZONTAL TRANSVERSE SECTION THROUGH ORBICULAR LIGAMENT.

extensors; *internally*, the flexors carpi ulnaris and sublimis digitorum, and the common tendon of the other extensors; also the ulnar nerve and posterior interosseous recurrent artery.

Joint Surfaces.—The lower end of the humerus has two distinct articular facets for the radius and ulna. The radial facet is on the outer

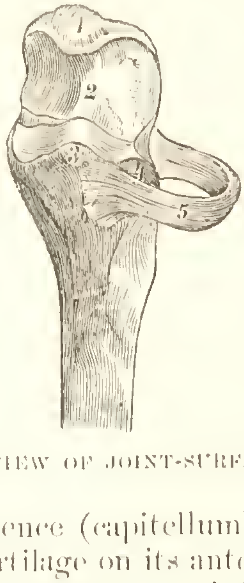


FIG. 202.—FRONT VIEW OF JOINT-SURFACES OF LEFT ULNA.

side, and is a rounded eminence (capitellum) chiefly on the front of the bone, being covered with cartilage on its anterior aspect only. The inner or ulnar surface is called the trochlea, and is hollow in the centre, and limited externally and internally by two prominent lips. The inner lip,

by its prominence below, forms an expansion which is adapted to an inward projection of the coronoid process of the ulnar, and is only used in flexion; the outer lip of the trochlea is everted at the posterior superior part, and forms a surface which corresponds to another on the outer aspect of the olecranon, which is only used in complete flexion, and which does not come into contact with any other part of the humerus. In flexion and extension the ulna is, of course, the bone chiefly engaged, and moves forwards and backwards on the trochlear surface of the humerus, but in these motions the radius also moves by its cup-shaped depression on the capitulum, by a ridge internal to the cup, on the groove between that process and the trochlea. In semiflexion and semipronation (the motions

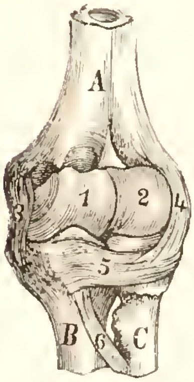
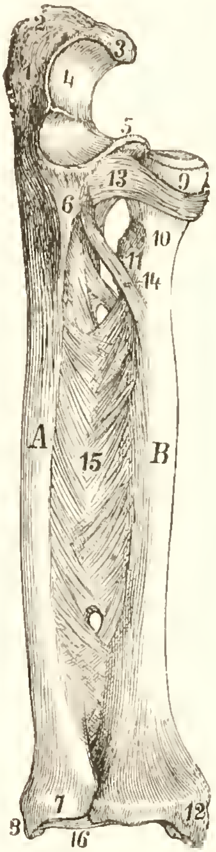


FIG. 203.—FRONT VIEW OF LEFT ELBOW JOINT.

A. Humerus. B. Ulna. C. Radius. 1. Trochlea. 2. Capitellum. 3. Int. lat. and 4. Ext. lat. lig. 5. Orbicular, and 6. Oblique lig.



A. Ulna.
B. Radius.
1. Olecranon.
2. Tubercles of same.
3. Hamulus of same.
4. Great sigmoid cavity.
5. Coronoid process.
6. Tuberosity of ulna.
7. Capitellum ,,
8. Styloid process of ulna.
9. Head of radius.
10. Neck ,,
11. Tubercle of radius.
12. Styloid processes.
13. Orbicular ligt.
14. Oblique ,,
15. Interosseous ligt.
16. Interartic. fibro-cartilage.

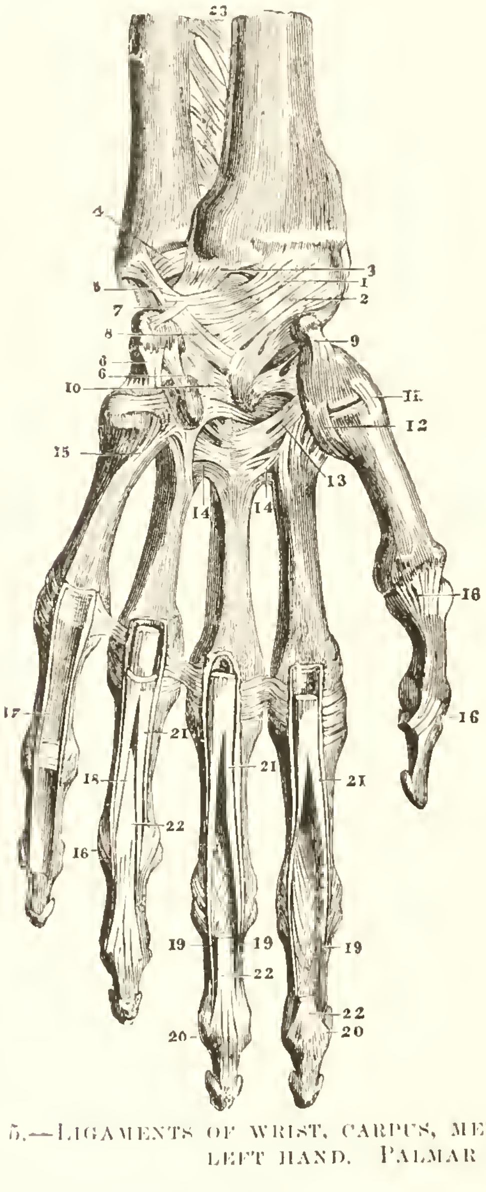
FIG. 204.—LIGAMENTS BETWEEN LEFT RADIUS AND ULNA. FRONT VIEW.

of pronation and supination take place not in the humero-ulnar joint, but in the radio-ulnar) it is most completely in contact with the capitulum. In complete flexion the anterior margin of the radial head rests against the depression above the capitellum, and in complete extension and supination, the anterior border of the head of the radius is only just in contact with the inferior surface of the capitellum. The joint between the capitulum and radius is an arthroidal one.

Radio-Ulnar Articulations.—The bones of the forearm are connected by joints at their upper and lower ends, and by an interosseous ligament between their sheaths, forming, 1, a superior radio-ulnar; 2, middle radio-ulnar; and, 3, inferior radio-ulnar joints.

Superior Radial Ulnar Joint.—In this articulation are the inner side of the circumference of the radial head and the lesser sigmoid cavity of the ulna. It is a lateral ginglymus, and its surfaces are covered with cartilage and lined by a pouch of the synovial membrane of the elbow joint, and it has but one ligament.

The *Orbicular* or *Annular Ligament* is a strong flat band of ligamentous fibres about a quarter of an inch wide. It is stronger behind, and forms four-fifths of a circle which surrounds the head of the radius, keeping it firmly in



1 2 3. Ant. radio carp.
4. Fibro-cart.
5. Ulno-carp.
6 7 8. Intercarp.
9. Trapezo-scaphd.
10. Magno cuneiform.
11. Trapezo-metacarp. dors.
12. „ „ palm.
13. Ligament from trapezium to second and third metacarpals.
14. Transverse basal intermetacarpal.
15. Oblique carpo-metacarp.
16. Lat. lig. of phalanges.
17. Fibrous sheath of flexors.
18. Tendons of sublimis and profundus.
19. Insertions of sublimis.
20. Insertion of profundus.
21. Tendon of sublimis.
22. Tend. flex. profund.
23. Intoss. lig. The transverse ligs. between the heads of the metacarpals are shown.

FIG. 265.—LIGAMENTS OF WRIST, CARPUS, METACARPUS, AND PHALANGES OF LEFT HAND. PALMAR ASPECT.

relation with the ulna, and is attached by its extremities to the anterior and posterior parts of the lesser sigmoid cavity of the ulna. It is broader at the upper part of its circumference, and there securely keeps the radius in its position. Its lower edge is free and fits round the neck of the radius. Its outer surface is strengthened by the external lateral ligament of the elbow, and the supinator brevis arises from it. Its inner surface is smooth and covered by the synovial membrane, and parts of the external and anterior ligaments of the elbow are connected with its upper border.

The *Synovial Membrane* is continuous with that of the elbow, and projects below between the lower margin of the annular ligament and the neck of the radius.

Movements.—These are limited to rotation of the head of the radius upon the lesser sigmoid cavity of the ulnar, within the annular ligament. Forward rotation is called *pronation*, and rotation backwards is termed *supination*. These movements will be more fully described when the other radial articulations have been studied.

Middle Radio-Ulnar Ligaments.—Two ligaments connect the shafts of the radius and ulna; they are the interosseous and oblique.

The *Oblique* or *Round Ligament*, or ligament of Weitbricht, is a slender roundish band above the interosseous membrane, and passes down and out, having an opposite direction to that of the interosseous membrane, and is attached above to the tubercle of the ulna at the base of the coronoid process, and inferiorly to the radius just below the bicipital tuberosity. It divides the space above the interosseous membrane into two parts, and appears to be a substitute for it in this position; but it is sometimes absent. As just stated, it passes from the ulna to the radius, while the interosseous ligament passes from the radius to the ulna. The posterior interosseous artery passes to the back between the oblique ligament and the upper border of the interosseous membrane.

The *Interosseous Ligament* or *Membrane* is a broad, thin, aponeurotic layer, which passes obliquely down and in from the interosseous ridge of the radius to that of the ulna. It forms an incomplete septum between the muscles of the front and back of the forearm. It is deficient above at its superior border, which is about an inch below the radial tubercle. This space (hiatus interosseus) transmits the posterior interosseous vessels. At its middle it is broader than at either end, and it has an oval aperture just above its lower margin through which the anterior interosseous artery passes to the back of the forearm. There are also smaller apertures in it for the passage of blood-vessels. This ligament connects the bones and gives origin to the deep flexors and extensors. On its posterior surface are two or three fibrous bands which pass obliquely from the ulna towards the radius, having a direction opposite to those of the other fibres of this membrane, and similar to that of the oblique ligament.

Relations.—*In front*, at its upper three-fourths, with the flexor profundus digitorum, on the inner side the flexor longus pollicis, on the outer and between them the anterior interosseous vessels and nerve. At its lower fourth with the pronator quadratus. *Behind* it are, from above downwards, parts of the supinator brevis, extensor ossis metacarpi pollicis, primi and secundi internodii pollicis and extensor indicis, and near the wrist are the anterior interosseous artery and posterior interosseous nerve.

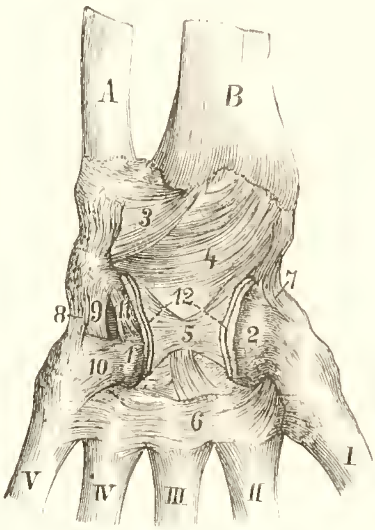
Directions.—The annular ligaments and tendons must be removed from both surfaces of this and the wrist joint, and the ligaments cleaned. The student should first dissect the wrist joint, and when that is done he will be able to more thoroughly examine the lower radio-ulnar articulation.

The **Radio-Carpal** or **Wrist Joint** is an arthrodia, but has some of the characteristics of an enarthrodial joint. It is formed by the lower end of the radius and under-surface of the triangular fibro-cartilage above, and

the upper surface of the scaphoid, semilunar, and cuneiform bones below. There are four ligaments uniting the osseous surfaces, which are coated by a thin layer of cartilage. The ligaments are, *anterior*, *posterior*, *and two lateral*. The pisiform bone has nothing to do with this joint, and the ulna is excluded from it by the triangular fibro-cartilage.

The *Anterior Ligament* is a broad fibrous band consisting of three fasciculi. Some of its fibres have a nearly transverse direction, and others diverge as they descend. It is attached above to the anterior margin of the lower end of the radius, to its styloid process, to the fibro-cartilage and to the ulna; and its fibres pass obliquely down, and in and out, to be inserted into the palmar surfaces of the scaphoid, semilunar, and cuneiform bones, partly blending with the palmar carpal ligaments. It is perforated by many vessels, and is in contact, in *front*, with the tendons of the flexor profundus and longus pollicis, and *behind*, with the synovial membrane.

The *Posterior Ligament* is also membranous, but not so thick and



A. Ulnar.
B. Radius.
3. Ant. radio-ulnar.
4. Ant. radio-carpal.
5. Ant. intercarpal.
6. Ant. intermetacarpal.
7. Ext. lat. of carpus.
8. Int. " "
9. Piso-metacarpal.
10 and 11. Carpo-metacarpal.
12. Ant. annlr. lig. (cut).

FIG. 206.—LIGAMENTS OF RIGHT WRIST, CARPUS, AND METACARPUS. BACK VIEW, LEFT HAND.

1 to 5 are the metacarpal bones.

strong as the anterior. It is attached to the posterior border of the lower end of the radius and fibro-cartilage, and its fibres pass down and in, to be inserted on the dorsal surface of the scaphoid, semilunar, and cuneiform bones, being continuous with the dorsal carpal ligaments. It is in relation, in *front*, with the synovial membrane, and *behind*, with the extensor tendons.

The *External Lateral Ligament* (Radio-carpal) is a short, strong band passing from the apex of the styloid process of the radius to a rough surface on the outer side of the scaphoid, some of its fibres going to the trapezium and anterior annular ligament.

The *Internal Lateral Ligament* is round, but longer and smaller than the external. It extends from the end of the styloid process of the ulnar, and divides into two fasciculi, one of which is attached to the rough upper and inner part of the cuneiform; the other to the pisiform bone and

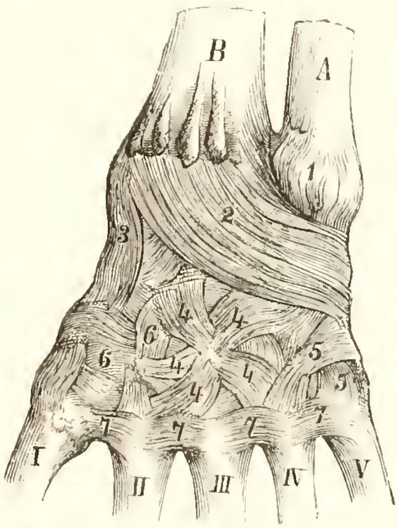
annular ligament, and is continuous with the internal lateral ligament of the carpus.

Dissection.—To expose the synovial membrane and joint surfaces, cut through the posterior ligament near the carpus and separate the bones, after having studied the movements of the wrist.

The *Synovial Membrane* passes from the radius and triangular fibro-cartilage to the inner surface of the ligaments, and after lining these, passes to the margins of the opposite surfaces of the carpal bones above their interosseous ligaments. This joint sometimes communicates with the inferior radio-ulnar articulation through an aperture in the triangular fibro-cartilage which separates the two.

Relations.—In *front*, the flexor, and *behind* the extensor tendons. At its outer and back part is the radial artery, and the ulnar artery is near to its lower and inner part, in front. The anterior and posterior carpal arteries and posterior interosseous nerve are also in contact with it.

Nerves.—The ulnar and posterior interosseous.



A. Radius.
B. Ulna.
1. Post. radio-ulnar.
2. Post. radio-carpal.
3. Ext. latl.
4. Dorsal intercarpal.
5 and 6. Carpo-metacarpal.
7. Intermetacarpal.

FIG. 207.—LIGAMENTS OF RIGHT WRIST, CARPUS, AND METACARPUS. FRONT VIEW, LEFT HAND.

1 to 5 are the metacarpal bones.

The *Arteries* are the anterior and posterior carpal and the radial and ulnar, ascending branches from the deep palmar arch, and anterior and posterior interosseous.

Movements.—The wrist has most of the properties of a condyloid articulation, and is capable of flexion, extension, abduction, adduction, and circumduction, but is quite incapable of the rotation movements which are characteristic of true enarthrodial joints.

In *Flexion* the hand passes forwards and inwards, and the first row of carpal bones glides from before back on the radius and projects behind, stretching the posterior ligament.

In *Extension* the hand is carried back and out, and the first row of carpal bones moves in the opposite direction and renders the anterior ligament tense. This movement is freer than flexion.

In *Abduction* the outer border of the hand is drawn away from the middle line of the limb, and the carpal bones move transversely inwards.

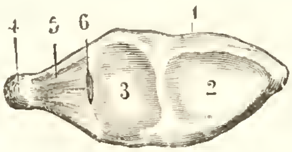
The internal lateral ligament is rendered tense, and the motion is checked by the meeting of the styloid process of the radius with the scaphoid.

In *Adduction* the hand is moved towards the ulnar side and the carpal bones pass transversely outwards. This motion is freer than abduction, and is limited by the external lateral ligament.

Joint Surfaces.—The triangular articular surface of the radius is divided by an antero-posterior line into an outer, triangular and an inner square-shaped surface, and these with the triangular fibro-cartilage form an arch which receives the upper convex ends of the first row of carpal bones. The scaphoid is received into the outer radial facet, the semilunar into the square-shaped facet, and triangular fibro-cartilage, while the cuneiform is in contact with the ligaments; but sometimes the fibro-cartilage is divided between the semilunar and cuneiform, the smaller part of it being for the latter bone, which is also in contact with the ligaments.

Circumduction.—In this movement the hand describes a cone whose base is at the fingers and apex at the wrist, and this being a combination of the four other movements, it necessarily moves most freely in the directions in which movement is freest; viz. in extension and adduction.

Flexion of the hand is produced by the flexor carpi radialis, palmaris longus, flexor carpi ulnaris, supinator longus, flexors sublimis and profundus, flexor longus pollicis and extensor ossis metacarpi pollicis.



1. Radius.
2. Its surface for scaphoid.
3. Surface for semilunar.
4. Styloid of ulna.
5. Triang. lig.
6. Aperture in fibro-cartilage.

FIG. 208.—LEFT RADIO-CARPAL ARTICULAR SURFACES, SEEN FROM BELOW.

Extension is brought about by the extensors carpi radialis longior and brevior, extensor communis digitorum, extensor minimi digiti, extensor carpi ulnaris, extensor indicis, and extensor primi and secundi internodii pollicis.

Abduction by the flexor carpi radialis, extensor carpi radialis longior and brevior, extensor ossis metacarpi, and extensors primi and secundi internodii pollicis.

Adduction by the flexor and extensor carpi ulnaris.

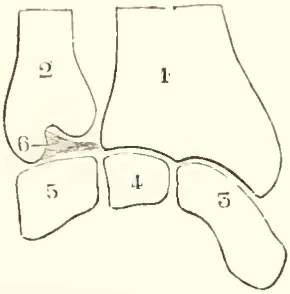
Inferior Radio-Ulnar Joint.—The lower semilunar end of the radius, which is concave, and the head of the ulna, which is convex to fit into it, and a fibro-cartilage and synovial membrane, are the structures which enter into the composition of this joint. It will be noticed that this arrangement is the opposite of that between the upper ends of the bones. The articular surfaces are covered by a thin layer of cartilage, and connected by scattered ligamentous fibres, forming a sort of capsule, which are named according to their position. This joint is a lateral ginglymus.

The *Anterior Radio-Ulnar Ligament* is a narrow band, extending from the anterior border of the sigmoid cavity of the radius to the anterior surface of the head of the ulna.

The *Posterior Radio-Ulnar Ligament* passes between similar spots at the back of the joint.

The *Triangular Fibro-Cartilage* is a thickish plate passing transversely

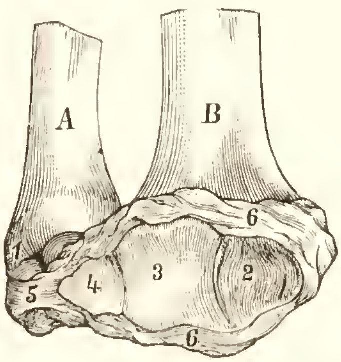
beneath the head of the ulna, and fixing it to the radius. It is attached by its base, which is thin, to a ridge separating the sigmoid cavity of the radius from its carpal articulating surface, and by its apex to a depression at the root of the styloid process of the ulna and to the side of that process.[1] This depression separates the head of the ulna from the styloid process. It is thicker at its margins than in its centre, which is occasionally perforated. Its borders are united to the anterior and posterior ligaments. Its upper surface is smooth and concave, and looks towards the ulna. Its lower



1. Radius.
2. Ulna.
3. Scaphoid.
4. Semilunar.
5. Cuneiform.
6. Triangular fibro-cartilage.

FIG. 209.—VERTICAL TRANSVERSE SECTION THROUGH RADIO-CARPAL AND INFERIOR RADIO-ULNAR JOINTS.

surface is also smooth and concave, and faces towards the cuneiform bone, forming part of the socket for the carpal bones. Both surfaces are lined by a synovial membrane. The lower one by the synovial membrane of the wrist, and the upper by one which is peculiar to the radio-ulnar articulation. The student will observe that this cartilage enters into the wrist and lower radio-ulnar joints. It also separates the carpal from the ulnar articulating surface of the radius, and prevents the lower end of the ulnar entering into the wrist joint, except in those cases in which it is perforated.



A. Ulnar.
B. Radius.
1. Ulnar styloid process.
2. Outer facet of radius.
3. Inner „ „
4. Triangular fibro-cartilage.
5. Ligamentum subcruentum.
6. Ant. and post. ligs. (cut).

FIG. 210.—RADIO-CARPAL JOINT-SURFACES. LEFT SIDE.

The *Synovial Membrane* of this joint is very loose, and is called the *membrana sacciformis*. It extends upwards between the radius and ulna, and horizontally inwards between the fibro-cartilage and ulna, and is very loose at the point where it is reflected from the ulna to the radius. It usually contains a large amount of synovia. If the fibro-cartilage be perforated, this membrane is continuous with that of the wrist.

Movements of the Radius.—In the upper radio-ulnar articulation, the

[1] It is sometimes connected to the apex and sides of the ulnar pit by a ligament called the *ligamentum subcruentum* because vessels pass along it. See fig. 210.

head of the radius is received into the lesser sigmoid cavity of the ulna. In the lower joint, the head of the ulna is received into the sigmoid cavity of the radius. This mechanism only permits of rotation of the radius round the upper and lower ends of the ulna, and the radius is prevented being displaced by the orbicular ligament above, and the fibro-cartilage below. A third articulation, the humero-radial, is also engaged in the rotatory movements of the radius.

In *Pronation*, which is forward rotation, the upper end of the radius passes from without inwards, within the annular ligament, and without changing its position to the upper end of the ulna; but the lower end moves over the ulna, from the outer to the inner side, and its shaft

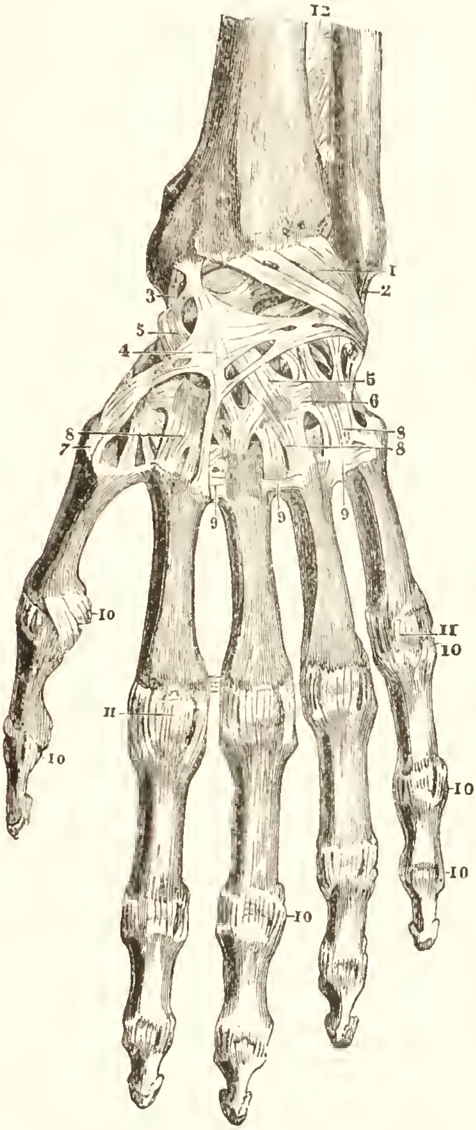
FIG. 211.—BONES OF LEFT ARM TO SHOW PRONATION AND SUPINATION.

obliquely crosses that of the ulna, describing half a circle, and carries with it the fibro-cartilage, which is movable at its insertion. The absence of ligamentous attachments to the upper end of the radius facilitates the movements at the upper articulation. The cup of the radius rotates forwards in pronation, and backwards in supination, on the capitellum, while its raised border glides on the oblique surface which is between the condyle and the outer border of the trochlear surface.

In *Supination* the sigmoid cavity of the radius glides backwards on the articular surface of the ulna, and the upper end of the bone rotates within the orbicular ligament from within outwards. The *posterior* liga-

ment checks *pronation*, and the *anterior* limits *supination*. The *interosseous* ligament is *tense in supination*, but *loose in pronation*.

In these motions the radius alone is movable,[1] and revolves round a vertical line which is inside its shaft, and which extends up through the head and neck of the bone, and down through the centre of a circle, of which the lesser sigmoid cavity of the ulna is a segment. If this line be prolonged upwards it will pass through the centre of the humeral head.



1. Post. rad. carp.
2. Int. lat.
3. Ext. lat.
4. Dorsal carp.
5. Deep carpal.
6. Magno-unciform.
7. Trapezio-metacarp.
8. Carpo-metacarp.
9. Transverse intermetacarp.
10. Interphalangeal.
11. Fibrous expansion from extensors to the lateral metacarpo-phalangeal ligaments.
12. Intoss. lig.

FIG. 212.—LIGAMENTS OF BACK OF WRIST, CARPAL, METACARPAL, AND PHALANGEAL ARTICULATIONS OF LEFT HAND.

The hand follows the radius in its movements, being almost completely shut off from articulating with the ulna by the fibro-cartilage.

Pronation is produced by the pronators teres and quadratus, and partly by the flexor carpi radialis and extensor carpi radialis longior.

Supination is effected by the biceps and supinator brevis.

Surgical Applications.—These movements cease in fracture of either

[1] This is the ordinary view, but in fact, the lower end of the ulna rotates on the radius in these movements, and I have a paper in preparation which I think will demonstrate this fact.

bone of the forearm. If the ulna be broken it cannot support the radius in its rotation, and if the radius be broken it cannot move in its entirety. In setting fractures of one or both bones the splints should be applied with the hand supinated, because then the bones are most separated, and lie side by side. After the splints have been applied the hand may be placed in a semi-prone position, and it and the forearm supported in a large sling.

Joints of the Carpus.—These are, first, the articulations of the first carpal row; second, those of the second; and third, those of the two rows with each other. The pisiform does not enter into the carpal articulation, but has a separate one with the cuneiform.

Dissection.—Remove all the tendons and cellular tissue from the

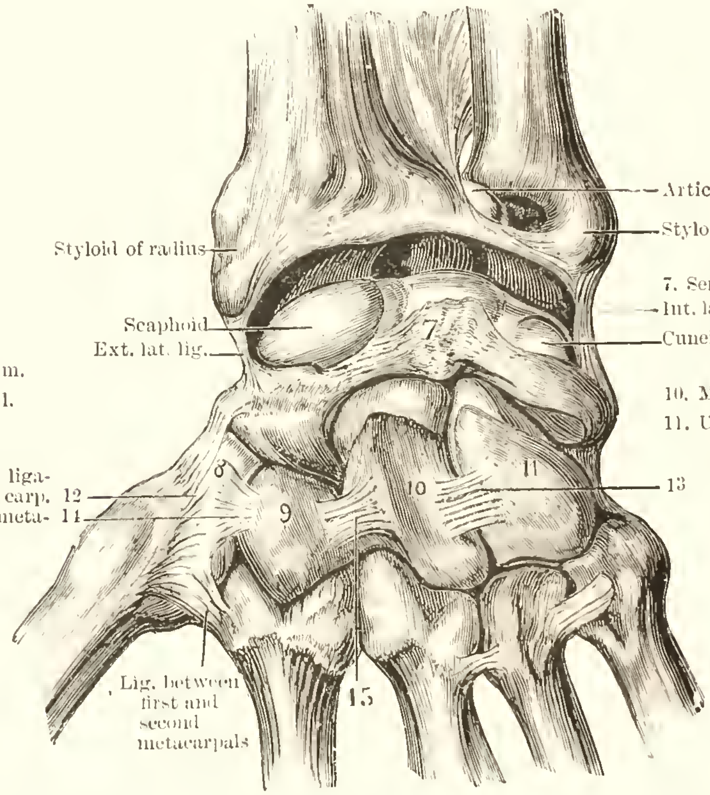


FIG. 213.—POSTERIOR VIEW OF ARTICULATIONS ABOUT LEFT WRIST.

hand, clean the ligamentous bands, and define the bands passing from the pisiform to the unciform and fifth metacarpal bones; also prepare the ligaments connecting the second row of carpal bones with each other and with the metacarpals.

Joints of the First Row.—These are arthrodia. The articular surfaces are coated with a thin layer of cartilage, and united by two dorsal, two palmar, and two interosseous ligaments.

Of the three bones of the first row which enter into these joints, the middle one, the semilunar, is joined to the lateral bones; namely, the scaphoid on the outer and the cuneiform on the inner side.

The *Palmar Ligaments* are transverse, less strong than the dorsal, and placed deeply under the anterior annular ligament.

The *Dorsal Ligaments* are also transverse, passing across the backs of these bones.

The *Interosseous Ligaments* connect the semilunar with the scaphoid and cuneiform, and are two narrow bundles of fibrous tissue on a level with the upper surface of these bones, and complete the lower wall of the radio-carpal joint. Their upper surfaces are smooth and lined by the synovial membrane of the wrist.

The **Pisiform** is joined to the front of the cuneiform by a capsular ligament and separate synovial membrane. It has, besides, two strong ligamentous bands, which connect it below with the unciform and fifth metacarpal bones. Occasionally it is connected with other metacarpal bones. The tendon of the flexor carpi ulnaris is partly inserted into it, and sometimes its synovial cavity communicates with the radio-carpal joint.

Joints of the Second Row.—These likewise are arthrodia, and are connected by three dorsal, three palmar, and three interosseous ligaments.

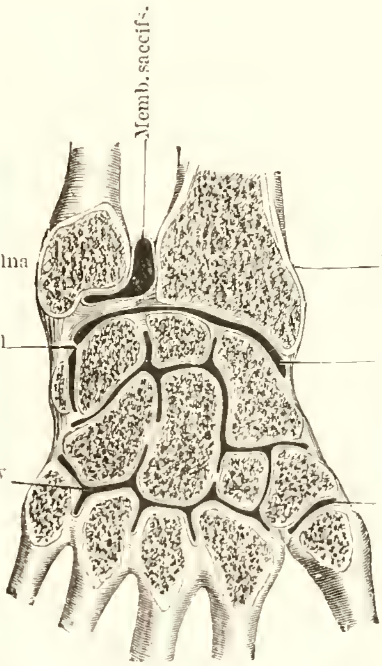


FIG. 214.—VERTICAL TRANSVERSE SECTION THROUGH THE JOINTS ABOUT THE LEFT WRIST. TO SHOW THE SYNOVIAL CAVITIES. PALMAR ASPECT.

The *Palmar Bands* pass transversely between the trapezium and trapezoid, the trapezoid and os magnum, and the magnum and unciform.

The *Three Dorsal* have a similar arrangement on the dorsal aspect.

The *Interosseous Ligaments* are usually three, but sometimes only two. They are much thicker than those of the first row, passing between the contiguous rough surfaces of the ossicles. There is a strong one between the magnum and unciform, another one between the trapezium and trapezoid, and a slender one between the magnum and trapezoid. Sometimes there is a small one between the magnum and scaphoid. This junction of the first to the second row of carpal bones by means of an interosseous band is rare. It may subdivide the large intercarpal synovial membrane, or it may be perforated by it.

Joints of the Two Rows with each other.—The ligaments connecting these are anterior or palmar, posterior or dorsal, and external and internal lateral.

The *Anterior Ligaments* consist of strong, short, irregular fibres, which pass obliquely between the two rows on the palmar surface (the pisiform being excepted): they converge towards the magnum.

The *Posterior Ligaments* are longer and looser fibres passing obliquely between the bones.

The *Lateral Ligaments* are very short. The *external* is the stronger and more distinct, and passes between the scaphoid and trapezium. The *internal* connects the cuneiform and unciform. They are continuous with the lateral ligaments of the wrist joint.

Dissection.—Divide the lateral and posterior ligaments, connecting the two rows so as to open the joint from behind; separate the articular surfaces, so that they and the synovial membrane may be studied.

The **Common Synovial Membrane** of the carpus is complicated and extensive. It lines the under surfaces of the three bones of the first row, sending two processes upwards between their adjacent surfaces. It then passes over the upper surfaces of the second row, and sends downwards three prolongations between them. These line their adjoining surfaces and cover the carpal ends of the four inner metacarpal bones. The joint between the pisiform and cuneiform has usually a separate synovial membrane.

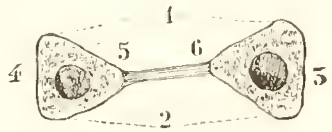


FIG. 214A.—TRANSVERSE SECTION THROUGH THE BONES OF THE FOREARM TO SHOW THE ATTACHMENTS OF THE INTEROSSEOUS LIGAMENTS AND THE SURFACES AND BORDERS OF THE RADIUS AND ULNA.

The four lines radiating from 1 go to the anterior surfaces and borders of both bones, and those from 2 to their posterior surfaces and borders. 3. External surface of radius. 4. Internal surface of ulna. 5. External border of ulna. 6. Internal border of radius.

Articular Surfaces.—There is a joint in the middle formed by the head of the os magnum being received into a cavity formed by the scaphoid and semilunar bones. This is a condyloid joint. There are two other joints; one on the outer side of this, formed by the projection of the scaphoid being received into the hollow formed by the trapezium and trapezoid. This is also of the condyloid variety. The joint on the inner side is formed by the unciform being received into a hollow of the cuneiform. This is more of the nature of an arthrodia A thin layer of cartilage covers the joint surfaces.

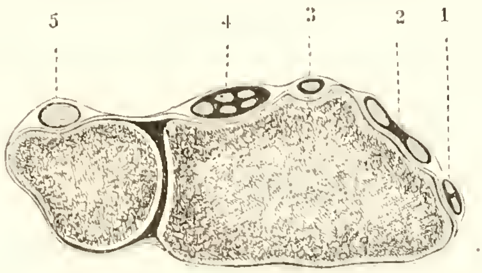
The student must observe that the outermost bone of the first row forms a projection which is received into a hollow formed by the two outer bones of the second row, and this hollow is much below the level of the other bones of this row. The two inner bones of the first row, and part of the outer, form a hollow to receive the condyloid projection of the os magnum and unciform. There is thus a sort of compensatory arrangement, a mutual giving and receiving, as what one row takes from another by means of its projection, it to some extent gives back by means of its corresponding hollow.

Movements.—The motions between the bones of the first and second rows between themselves are limited to a slight degree of gliding. The articular surfaces are flat, and the interosseous ligaments short, and there is more motion permitted in the first row than in the second, because the interosseous ligaments are looser or sometimes non-existent.

The *Inter-* or *Carpo-Carpal Movements*, i.e. those between the bones of the two rows, consist of flexion and extension, and although the joint is in part doubly condyloid, no rotation or lateral motion is permitted, unless the bones be slightly separated, and then these are very small. In the ordinary condition, rotation and lateral motion are prevented, not only by the ligaments, but by the inner part of the scaphoid striking against the os magnum, and by the cuneiform impinging against the unciform.

Flexion.—In this movement the palm of the hand approximates to the anterior surface of the forearm. The magnum and unciform glide backwards on the upper carpal row, and, projecting behind, render tense the posterior ligament. It is more limited than extension, and is checked by the contact of the bones and by the extensor tendons.

Extension.—In this movement the dorsum of the hand is approximated to the dorsal surface of the forearm. It is called *dorsi-flexion* by Meyer. It is more extensive than flexion, and the head of the magnum,



1. Tendons of ext. oss. met. poll. and primi intnodii.
2. Exts. carp. rad. long. and brev.
3. Ext. secundi intnod. poll.
4. Ext. com. and indicis.
5. Ext. carp. ulnaris.

FIG. 215.—VERTICAL TRANSVERSE SECTION OF LEFT RADIUS AND ULNA JUST ABOVE THE WRIST.

The ext. min. dig. is not shown, but lies equidistant between 4 and 5, between the bones.

and upper part of the unciform, glide forwards on the hollow of the upper row until motion is checked by the meeting of the bones and by the anterior ligaments and flexor tendons. Over-extension is permitted to some degree in the radio-carpal, inter- or carpo-carpal joints, because the upper articular surfaces of both rows of carpal bones are prolonged further on the dorsal than on the palmar aspect, and also because of the weakness of some of the carpal and carpo-metacarpal palmar ligaments.

Carpo-Metacarpal Joints.—The metacarpal bones are articulated with the second carpal row, the joint between the metacarpal of the thumb and trapezium being a separate one.

The *metacarpal of the thumb* is connected by a thick but loose capsule which passes from the circumference of the base of the metacarpal bone to the rough edge around the articular surface of the trapezium. It is thickest outside and behind, and is lined by a separate synovial membrane. It is an arthrodial joint, and possesses great power of movement on account of its saddle-shaped articular surface. On section each bone appears to be received into a cavity of the other, according to the direction the section takes. For this reason it has been described as a joint

'by reciprocal reception.' It is capable of the four angular movements: flexion, extension, abduction, and adduction, also of circumduction and opposition.

In *flexion* the metacarpal bone is brought towards the palm, and in *extension* movements in the opposite direction take place. *Flexion* is produced by the flexor brevis, abductor et opponens pollicis, and *extension* by the extensores primi et secundi pollicis.

In *abduction* and *adduction* the metacarpal is approximated to, or removed from, the forefinger; the former is produced by the extensor ossis metacarpi, and the latter by the adductor pollicis.

In *opposition* the ball of the thumb is turned towards the tip of each finger by motions partly circumductory; and in holding a pen or picking

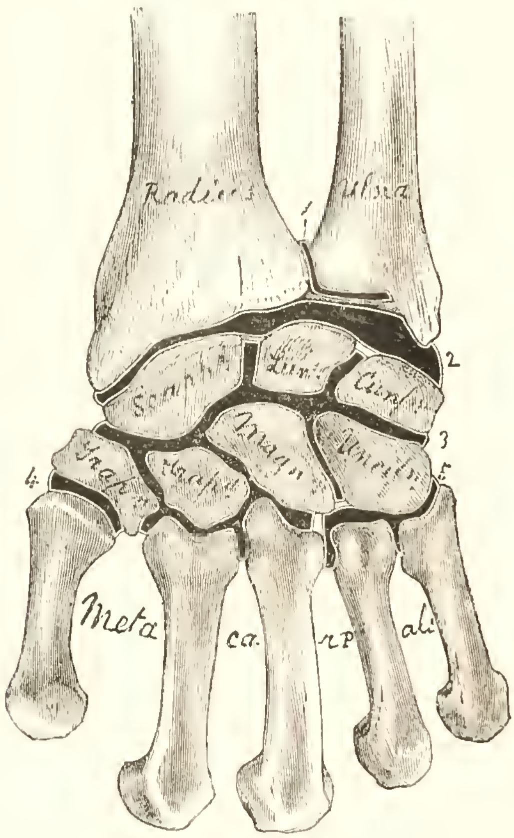


FIG. 216.—SYNOVIAL CAVITIES OF THE LEFT CARPUS. DORSAL VIEW.

1. Radio-ulnar. 2. Radio-carpal. 3. Intercarpo-metacarpal (the largest). 4. Trapezio-metacarpal. 5. Unci-metacarpal.

up a pin, the metacarpal of the thumb, and the thumb phalanges, acted upon by their flexors, are brought into opposition to the fingers.

Circumduction is a combination of these movements, and is produced by the short and long muscles acting upon the metacarpal bone and phalanges of the thumb.

Articulations of the Metacarpals with the Second Carpal Row.—These joints are arthrodial, and are connected mainly by two dorsal ligaments to each digit, except to the little finger; by one palmar to each, except the third metacarpal; and by interosseous ligaments.

The *Dorsal Ligaments* are the strongest and most distinct. The

second metacarpal has two fasciculi, one from the trapezium, the other from the trapezoid. The third has one from the os magnum. The fourth

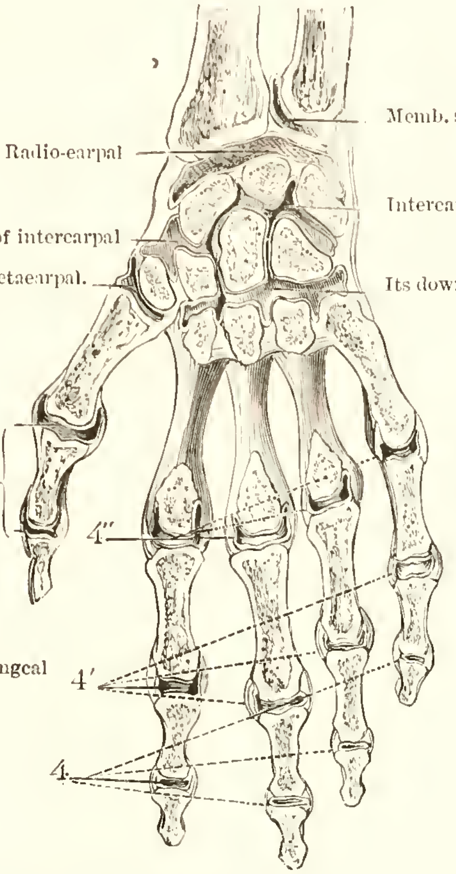
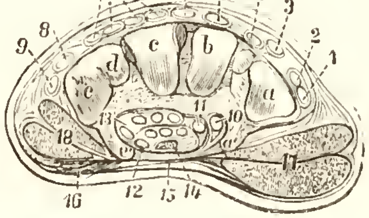


FIG. 217.—TRANSVERSE VERTICAL SECTION OF RIGHT HAND TO SHOW THE SYNOVIAL CAVITIES.

has two, one from the magnum, and another from the unciform; and the fifth has only one, and that from the unciform.

The *Palmar Ligaments* run, like the dorsal, longitudinally, and are

1. Tend. ext. oss. met.
2. Tend. ext. prim. intnod.
3. Tend. ext. secundi.
4. Ext. indicis.
5. Ext. carp. rad. long.
6. Ext. carp. rad. brev.
7. Tendons ext. com. dig.
8. Tendon ext. min. dig.
9. Tend. ext. carp. uln.



10. Flex. carp. rad. tendon.
11. Flex. long. poll. ,,
12. Tendons flex. sub. dig.
13. ,, prof. ,,
14. Median nerve.
15. Palmar fascia (cut).
16. Palmaris brevis.
17. Thenar muscles.
18. Hypothenar muscles.

FIG. 218.—TRANSVERSE SECTION OF THE RIGHT HAND BETWEEN CARPUS AND METACARPUS.

a, *b*, *c*, *d*, *e*. Articular surfaces of the trapezium, trapezoid, magnum, and unciform. *a*. Palmar ridge of trapm. *e′*. Unciform process, between *a* and *e* the cut annular ligt. The vessels are not represented.

weaker and less constant. They resemble the dorsal, with the exception of those for the third metacarpal, which has three ligaments. An external

one from the trapezium, which is above the sheath of the tendon of the flexor carpi radialis; a middle one from the magnum; and an inner one from the unciform.

The *Interosseous Ligaments* are short, thick fibres limited to one portion of this articulation. They connect the inferior angles of the magnum and unciform with the adjacent surfaces of the third and fourth metacarpals. Sometimes they isolate the joints of the last two metacarpals with the unciform from the rest of the carpal and metacarpal joints; but it is oftener divided into two, and does not form a complete separation.

Dissection.—These interosseous bands may be exposed by dividing the transverse ligament joining the third and fourth metacarpals, and by opening the joint between the unciform and the last two metacarpals.

The *Synovial Membrane* is a continuation of that between the two rows of carpal bones, but sometimes the joint between the unciform and fourth and fifth metacarpals has a separate one.

Movements.—This is limited to a slight antero-posterior gliding of the articular surfaces on each other. The fifth metacarpal is more movable than the fourth, and the second and third have scarcely any appreciable motion. The metacarpals of the ring and little fingers are capable of very slight ab- and adduction.

Union of the Metacarpal Bones with each other.—The metacarpal bones are joined at their carpal and phalangeal extremities, the joints at their bases being covered with cartilage and connected by dorsal, palmar, and interosseous ligaments.

The *Dorsal* and *Palmar* are usually three in number, and pass transversely from one bone to the other on the dorsal and palmar surfaces. The *Interosseous* ligaments pass between the rough contiguous surfaces just beneath their lateral articular facets.

The *Synovial Membrane* lining the lateral facets is part of that between the two rows of carpal bones.

The *Digital ends* of the four inner metacarpals are joined by a narrow fibrous transverse band which passes across their anterior surface and is blended with the metacarpo-phalangeal ligaments. It is the deep transverse ligament which was seen in the dissection of the hand, and its posterior surface blends with the ligaments just named, but its anterior has four grooves for the passage of the flexor tendons.

Dissection.—Divide the ligaments which remain unent on the posterior aspect of these articulations, and separate the articular surfaces.

Joint Surfaces.—The metacarpal of the index finger has, at its base, a hollow articular surface to receive the prominence of the trapezoid, and it articulates laterally with the trapezium and magnum. The metacarpal of the middle finger articulates with the magnum, and that of the ring finger with the magnum and unciform. The little finger metacarpal articulates with the unciform.

Synovial Membranes.—They are usually two, between the carpal and metacarpal bones: a separate one for the thumb, and prolongations of the common carpal synovial membrane for the others. As already stated, there may be a separate synovial sac for the joint between the unciform and two inner metacarpals.

Dissection.—Remove the tendons from both surfaces and the tendinous expansions, and clean the anterior and lateral ligaments. One of the meta-

carpo-phalangeal joints should be opened to study the articular surfaces. The *interphalangeal joints* must be prepared in the same way.

Metacarpo-Phalangeal Articulations.—These are condyloid joints with hinge movements, and are formed by the rounded heads of the metacarpal bones being received into the shallow glenoid cavities in the bases of the first phalanges. The bones are kept in contact by the ligaments, which are *anterior* and *lateral*, and by the flexor and extensor tendons.

The *Anterior Ligaments* are five, one to each finger, and are thick, strong, longitudinal fibro-cartilaginous bands, on the palmar surface of the

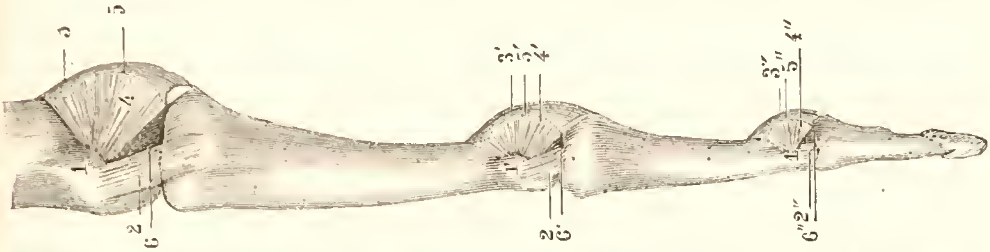


FIG. 219.—LATERAL LIGAMENTS OF A RIGHT FINGER IN EXTENSION.

1 1′ 1″. Tubercles to which the lat. ligs. are attached. 2 2′ 2″. Post. parts of lat. ligaments relaxed. 3 3′ 3″. Anterior ligs. 4 4′ 4″. Anterior parts of lateral ligaments. 5 5′ 5″. Dotted line showing limit of bone.

joint in the space between the lateral ligaments, to which they are united. They are loosely connected to the heads of the metacarpal bones around their articular surfaces, but firmly to the bases of the first phalanges. Their *anterior* surface is closely adherent to the transverse ligament, and forms a groove for the flexor tendons, the sheath of which is connected to each margin of the groove. Their *deep* surface forms part of the articular surface for the head of the metacarpal bone, and is covered by a simple synovial membrane. The dorsal aspect of these joints is covered by the extensor tendon, which acts as a posterior ligament and sends down expansions on each side, serving as a capsule for the joint. Cruveilhier named these the *glenoid ligaments*. In the metacarpo-phalangeal joint

FIG. 219A.—LIGAMENTS OF THE MIDDLE FINGER. ONE HALF. PALMAR ASPECT.

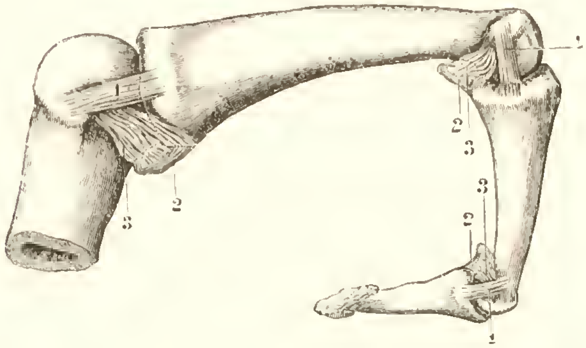
1. Metacarpal bone.
2. First phalanx.
3. Second ,,
4. Third phalanx.
5, 7. Lateral ligts.
6, 10. Anterior ligts.
8. Head of first phalanx.
9. Base of second phalanx.

of the thumb, two sesamoid bones are connected with the anterior ligament, and receive most of the fibres of the lateral ligaments.

The *Lateral Ligaments* are strong, round cords at either side of the joint, and are triangular. Their apices are fixed to the tubercle on the side of the head of the metacarpal bone, and, passing forwards and downwards, their bases are inserted into the sides of the bases of the phalanges, and into the anterior ligament.

Movements.—These are flexion, extension, abduction, adduction, rotation, and circumduction.

In *Flexion* the phalanx glides forwards under the head of the metacarpal bone, which is left exposed, and forms the knuckle. The extensor



1 1 1. Posterior parts of lat. ligs. tense.
2 2 2. Anterior ligs.
3 3 3. Anterior part of lat. ligs. relaxed.

FIG. 220.—LATERAL LIGAMENTS IN FLEXION.

tendon and lateral ligaments are made tense, and the movement is checked by the ends of the fingers meeting in the palm.

In *Extension* the phalanges move back and form an angle with the

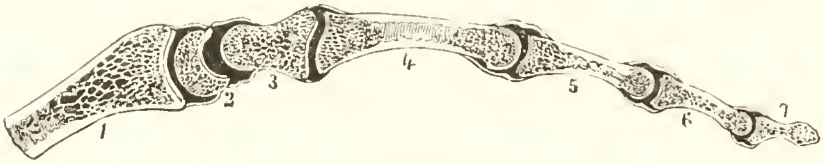
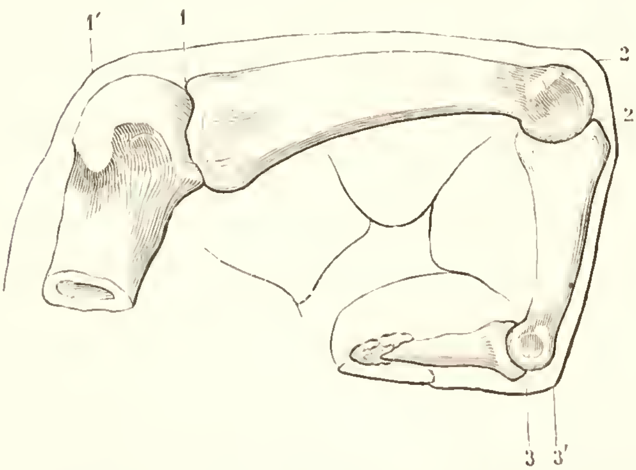


FIG. 221.—ANTERO-POSTERIOR VERTICAL SECTION THROUGH RADIUS, SEMILUNAR, MAGNUM, METACARPAL, AND PHALANGES OF MIDDLE FINGER, SHOWING SHAPE OF JOINT SURFACES AND THE SYNOVIAL CAVITIES.

1. Radius. 2. Lunar. 3. Magnum. 4. Metacarpal. 5, 6, 7. Phalanges.

metacarpals. The flexor tendons and anterior ligaments are rendered tense and check this movement.

Abduction and *Adduction* are somewhat limited. In these lateral



1. Articular line of metacarpo-phalangeal joint.
1′. Prominence of head of metacarpal.
2. First inter-phalangeal articular line.
2′. Prominence of the distal end of first phalanx.
3. Second interarticular phalangeal phalanx.
3′. Prominence of head of second phalanx.

FIG. 222.—POSITION OF PHALANGES AND OF THE INTERARTICULAR LINES IN FLEXION.

motions one finger passes from or towards its fellow. The lateral ligament on that side of the joint which is convex will be tightened, and the opposite one will become relaxed. These movements are freest in the thumb, and the little finger enjoys more ab- than adduction.

Rotation is permitted to a slight extent in consequence of the laxity of the ligaments.

Circumduction is freest in the thumb, index, and little fingers, and it aids the thumb and fingers in the movement of opposition.

The first phalanx of the thumb is flexed by the abductor and flexor brevis pollicis and by the flexor longus and adductor pollicis; *extended* by the extensors primi and secundi internodii; *abducted* by the extensor ossis metacarpi pollicis; and *adducted* by the adductor pollicis.

The first phalanges of the fingers are *flexed* by the flexors sublimis and profundus, the interossei and lumbricales; *extended* by the extensor communis; *adducted* by the palmar interossei; and *abducted* by the dorsal interossei.

Inter-phalangeal Articulations.—These are ginglymoid joints, and are united by an anterior and two lateral ligaments which are similar to those

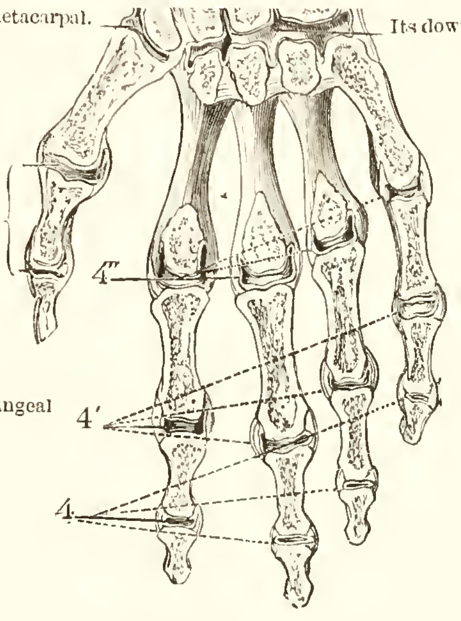


FIG. 223.—TRANSVERSE VERTICAL SECTION OF RIGHT HAND TO SHOW THE SYNOVIAL CAVITIES.

of the metacarpo-phalangeal joints, the extensor tendon acting as a posterior ligament.

The *Anterior Ligament* is not so strong, but has a similar attachment to that of the metacarpo-phalangeal joint. The lateral ligaments are triangular, and each is fixed by its apex to the anterior part and side of the first and second phalanges. The ligaments of the joints of the second with the last phalanx are much less strongly marked than the others. A simple synovial sac lines each joint cavity.

Movements.—The inter-phalangeal joint can be flexed and extended.

In *Flexion* the distal phalanx moves under the proximal, and the movement is limited by the extensor tendon, the posterior parts of the lateral ligaments, and by the meeting of the bones. This movement is most extensive in the first phalangeal joint.

In *Extension* the distal phalanx moves backwards into a straight

line with the proximal and is checked by the flexor tendons, the anterior ligament and the anterior portions of the lateral ligaments. It will be noted that flexion is more extensive than extension.

The second phalanx of the thumb is *flexed* by the long flexor; *extended* by the extensor secundi internodii, flexor brevis, abductor and adductor pollicis.

The second phalanges of the fingers are *flexed* by the flexor sublimis, and *extended* by the interossei and lumbricales aided by the common extensor.

The third phalanges are *flexed* by the flexor profundus, and *extended* by the interossei and lumbricales.

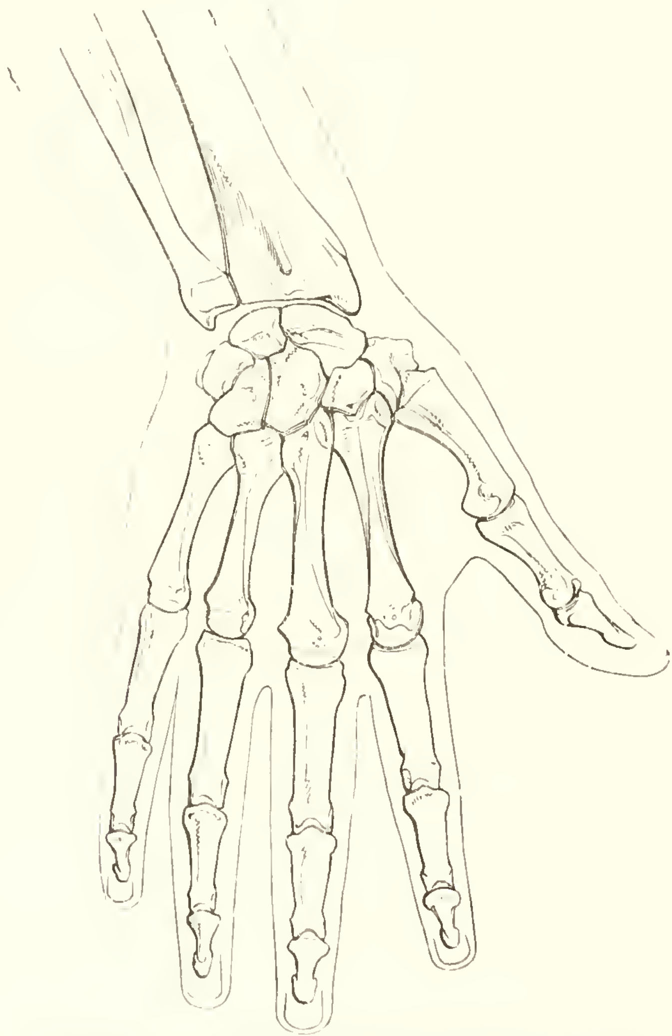


FIG. 221.—THE BONES OF THE MALE HAND TO SHOW THEIR RELATIONS TO THE SKIN. (MARSHALL.)

Articular Surfaces.—In the metacarpo-phalangeal joints the anterior rounded head of the inner four metacarpals is received into a slight hollow in the extremity of the first phalanx. In the inter-phalangeal joints the anterior end of each phalanx is marked by a trochlear surface, and is adapted to the posterior end of the next phalanx, which is transversely hollowed, and is provided with a crest which is adapted to the central depression of the opposite articular surface.

The student will note that there are five synovial membranes about the wrist: 1, The *membrana sacciformis* which lines the upper surface of the fibro-cartilage, the sigmoid cavity of the radius, and the head of the ulna; 2, lines the lower end of the radius and fibro-cartilage and the upper surfaces of the scaphoid, semilunar, and cuneiform; 3, is the largest and covers the contiguous surfaces of the two rows of carpal bones, sending two processes up and three downwards between the bones, the latter lining the carpal ends of the four inner metacarpal and sending down three pouches between their bases; 4, is for the trapezio-metacarpal joint; and 5, for the cuneo-pisiform articulation. Occasionally an interosseous ligament shuts

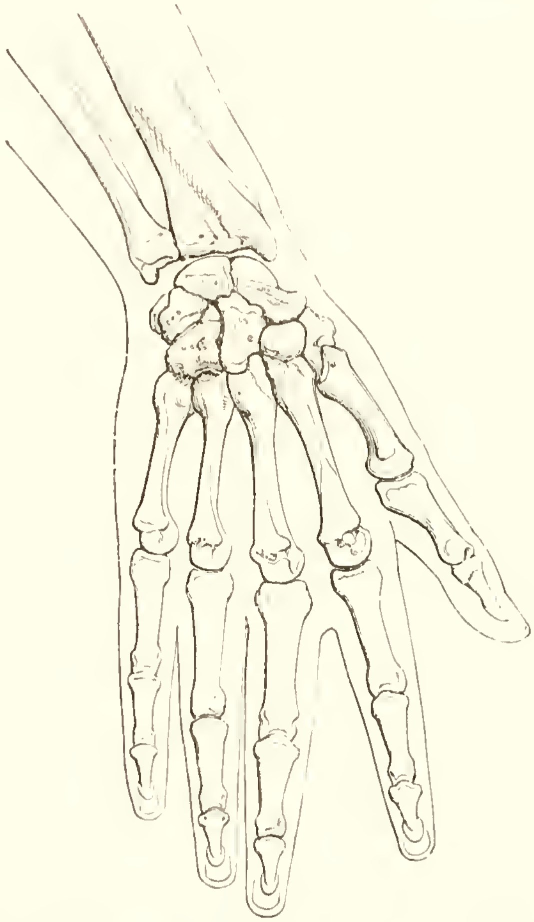


FIG. 225.—THE BONES OF THE FEMALE HAND. (MARSHALL.)

off the joint of the unciform with the metacarpals, forming a sixth synovial cavity; and rarely the intercarpal synovial membrane communicates with the radio-carpal one through deficiency of one of the interosseous ligaments.

Directions.—With a fine saw, the dissector should now make various longitudinal and transverse sections through the bones and joints, so as more completely to understand them and to become familiar with the thickness and extent of the articular cartilages and arrangement of the periosteum, which he should, in parts, separate from the bone and observe the vessels entering the latter. He will thus become acquainted with the structure and mechanism of the bones and joints, and learn at what parts they are strong or weak.

Tabular Summary or Synopsis of the Arteries of the Upper Limb.

The *Subclavian* continues into the arm as the

- 1. *Axillary*, which gives off the
  - Superior thoracic.
  - Acromio-thoracic, gives off
    - Muscular.
    - Acromial.
    - Humeral thoracic.
  - Long thoracic.
  - Alar thoracic.
  - Subscapular, gives off
    - Dorsalis scapulæ which gives off
      - Infrascapular
    - Muscular
  - External mammary.
  - Anterior circumflex.
  - Posterior „
- 2. *Brachial*, which gives off these, and divides into radial and ulnar
  - Branch to coraco-brachialis.
  - Superior profunda, gives off
    - Muscular.
    - Anastomotic.
    - Posterior articular.
  - Nutrient.
  - Inferior profunda
    - Muscular.
    - Anastomotic.
  - Anastomotica magna.
  - Muscular and cutaneous.
- 3. *Radial*, which gives off
  - Recurrent radial.
  - Muscular and cutaneous.
  - Superficialis volæ.
  - Posterior carpal.
  - Anterior „
  - Metacarpal.
  - Dorsalis pollicis.
  - Dorsalis indicis.
  - Princeps pollicis.
  - Radialis indicis, and forms the deep palmar arch with the communicating branch of the ulnar, from which are given off the
    - Recurrent.
    - Three perforating.
    - Interossei (palmar).
- 4. *Ulnar*, which gives off
  - Anterior recurrent.
  - Posterior „
  - Common interosseous, gives off
    - Anterior, gives off
      - Recurrent.
      - Nutrient.
      - Muscular.
      - Anastomotic.
    - Posterior, gives off
      - Recurrent.
      - Muscular.
  - Muscular and cutaneous.
  - Metacarpal, gives off
    - Dorsal carpal.
    - Dorsal interossei.
  - Anterior carpal.
  - Communicating, and forms *superficial palmar arch* with superficialis volæ of radial, which gives off the
    - Four digitals.
    - Muscular.
    - Cutaneous.

Tabular Summary or Synopsis of the Origin and Distribution of the Nerves of the Upper Limb.

The brachial plexus gives off below the clavicle the

- Anterior thoracic, which gives off
  - External from 5th, 6th, 7th, and supplies pect. major.
  - Internal from 8th, and supplies pect. major and minor.
- Subscapular comes from 5th, 6th, 7th, 8th, and gives off
  - Upper, supplies subscapularis.
  - Middle „ „ and teres major.
  - Long „ latissimus dorsi.
- Circumflex comes from 5th, 6th, 7th, 8th, and divides into
  - Upper branch, supplies deltoid and skin.
  - Lower „ „ teres minor, and skin over shoulder, and has gangliform enlargement.
  - Articular to shoulder.
- Nerve of Wrisberg from 8th and 1st D., and is cutaneous to lower half of arm.
- Internal cutaneous, comes from 8th and 1st D., and gives off
  - Cutaneous to arm.
  - Anterior to forearm, and joins branch of ulnar.
  - Posterior „ „ nerve of Wrisberg and ulnar above and below elbow.
- External or musculo-cutaneous, comes from 5th, 6th, and 7th, and gives off
  - *In arm.*
    - Muscular to biceps, coraco-brachialis and brachialis anticus.
    - Articular to elbow and to humerus.
  - *In forearm.*
    - Anterior to forearm — cutaneous and joins radial.
    - Posterior „ — „ „ „ and ext. cuts. of mus.-spiral.
    - Articular to wrist.
- Median, which has no branches in the arm, comes from 5th, 6th, 7th, 8th, and 1st D., and gives off
  - *In the forearm.*
    - Muscular, to all the muscles in the front of the forearm except the flexor carpi ulnaris and ulnar half of the flexor profund. digitorum.
    - Anterior interosseous, which supplies the deep muscles.
    - Palmar cutaneous.
  - *In the hand.*
    - Muscular to abductor, opponens and outer head of flexor brevis pollicis.
    - Five digitals to the three and a half outer fingers on their palmar aspect.
- Ulnar, which comes from 8th and 1st D., or 7th, 8th, and 1st D., has usually no branches in the arm, and gives off
  - *In the forearm.*
    - Articular to elbow and wrist.
    - Muscular to flexor carpi ulnaris and ulnar half of flexor profundus digitorum.
    - Cutaneous to forearm and palm.
    - Dorsal cutaneous of hand, which supplies both sides of little, and ulnar side of ring finger on the dorsum.
  - *In the hand.*
    - Superficial palmar, which supplies the palmaris brevis, skin of palm, both sides of little, and ulnar side of ring finger on the palmar aspect.
    - Deep palmar, which is muscular, and supplies the muscles of little finger, the palmar and dorsal interossei, the two inner lumbricales, adductor pollicis, and inner head of flexor brevis pollicis.
- Musculo-spiral, which comes from 5th, 6th, 7th, 8th, and gives off
  - Internal cutaneous.
  - External „ (upper and lower).
  - Muscular to triceps, anconeus, subanconeus, supinator longus, extensor carpi longior, and often the brachialis anticus.
  - Ulnar collateral to triceps.
  - Radial, which gives off
    - External (cutaneous).
    - Internal, which divides into four *digitals* for the three and a half outer fingers on the dorsum.
  - Posterior interosseous
    - Muscular to supinators and extensors of wrist and fingers, excepting sup. long. and ext. carp. longior.
    - Articular to wrist; has gangliform enlargement.

Table of Veins of the Upper Limb.

The axillary continued from the brachial receives the	Basilic receives the	Anterior ulnar receives	Inner palmar digitals receive	Digital venus plexus for each finger
		Posterior ,, ,,	Inner dorsal digitals and vena salvatella	
		Median basilic ,,	Median receives	Deep veins accompanying brachial
	Brachial veins receive the	Superior profunda		
		Inferior ,,		
		Muscular	Deep palmar receives	Venæ comites of palmar arch
		Anastomotica magna	Ulnar digitals	
		Deep radial receives	Anterior interosseous receives	Muscular
		Deep ulnar ,,	Posterior interosseous receives	Articular
	Cephalic receives the	Radial receives	Dorsal outer digitals and median cephalic	Digital venus plexus for each finger to digitals
		Median cephalic receives	Median	
	Superior thoracic			
	Acromio- ,,			
	Long ,,			
	Alar			
	Subscapular			
	Anterior circumflex			
	Posterior ,,			

The two superficial palmar veins receive the outer and inner digitals respectively.

SUMMARY OF DISSECTIONS.

A brief repetition of the method of dissecting each region and of the structures found, layer by layer, is given in this section. I believe this will be found very serviceable to students who have already dissected and who are again about to prosecute dissections in a later stage of their curriculum.

DISSECTION OF UPPER LIMB.

PECTORAL REGION.

1. Incisions. 1. From the episternal notch to the xiphoid cartilage. 2. From the upper part of this incision to the insertion of the deltoid. 3. From the lower part of it another across the inferior boundary of the axilla to the upper third of the inner side of the arm. Reflect the skin.

2. In the subcutaneous cellulo-fatty layer dissect out the cutaneous acromial branches from the descending branches of the cervical plexus and the cutaneous nerves from the intercostals; also cutaneous twigs from the long thoracic, internal mammary, and superior thoracic arteries, and the accompanying veins and superficial lymphatics.

3. If the subject be a female note the position, relations, attachments, and sheath of the mammary gland; then remove and dissect it.

4. Define the aponeurosis of the pectoralis major; then reflect it.

5. Make out the attachments and relations of the pectoralis major, pectoralis minor, and serratus magnus, and define the regions of the sterno-mastoid and the insertions of the external oblique and rectus.

6. After reflecting the pectoralis major, make out the attachments of the costo-coracoid membrane and note the structures which pierce it; then reflect and define the attachments of the subclavius and dissect out the first part of the axillary artery and study its relations and its branches, also the cords of the brachial plexus and the axillary vein.

7. Reflect the pectoralis minor to expose the second part of the axillary artery and the accompanying nerves and veins, and dissect the external intercostals and their fasciae.

INFRA-CLAVICULAR REGION.

If the previous instructions have been followed, the boundaries of this place will have been disturbed, but if the pectoralis minor and the costo-coracoid membrane remain undisturbed the following dissection will expose the contents of the space.

1. Reflect the costo-coracoid membrane, which will be found to form part of the sheath of the pectoralis minor below, and above to be attached

to the clavicle. The first part of the axillary artery and its superior and acromio-thoracic branches and accompanying veins will be exposed. The cephalic vein will have been noticed piercing the costo-coracoid membrane, and the anterior thoracic nerves will be found piercing it. The supra-clavicular branches from the cervical plexus are in the subcutaneous tissue.

2. Dissect out the axillary vein, the cephalic emptying into it, and the branches corresponding to the artery, also the nerves accompanying the first part of the artery.

3. Reflect the pectoralis minor and dissect out the second part of the axillary artery and its branches, which are usually the long thoracic and the alar thoracic, also the accompanying veins and nerves, which latter are partly on the outer and partly on the inner side.

4. The external intercostal fascia and vessels should be dissected and their attachments observed, also the lateral cutaneous nerves of the inter-costals which pierce the muscles and fascia.

THE AXILLARY REGION.

1. The third part of the axillary artery and its branches, which are the subscapular and anterior and posterior circumflex, the accompanying veins, also the axillary vein and the median, ulnar, musculo-spiral, circumflex, and cutaneous nerves, all surrounding the vessels, should be dissected out.

2. The insertions of the pectoralis major, latissimus dorsi, teres major, as well as the origins of the biceps, coraco-brachialis, and long head of the triceps, should be defined.

3. The axillary lymphatic vessels and glands should also be cleaned and defined.

ANTERIOR BRACHIAL REGION.

1. Make an incision along the middle of the arm to just below the bend of the elbow. 2. Transverse ones on the outer and inner side at the outer ends of these incisions. 3. Reflect the skin.

2. In the subcutaneous superficial cellulo-fatty tissue find the cutaneous branches from the musculo-spiral, internal cutaneous, and lesser internal cutaneous. The basilic vein is on the inner side, and the cephalic on the outer.

3. Reflect this layer after dissecting out the structures enumerated so as to expose the deep fascia, then make out its processes and attachments.

4. Reflect the deep fascia or aponeurosis of the arm, and identify the following structures.

5. The biceps, coraco-brachialis, and origin of brachialis anticus.

6. The axillary artery and venæ comites, the median, the musculo-cutaneous, ulnar, internal cutaneous, and intercosto-humeral nerves.

BEND OF THE ELBOW.

1. The superficial veins in this region, namely, the termination of the median, the median-cephalic, the median-basilic, the origins of the cephalic, and the basilic, must be dissected out.

2. The branches of the internal cutaneous and musculo-cutaneous must be defined.

3. The insertion of the biceps and its expansion to the deep fascia of the forearm must be made out.

4. The origins of the supinators and extensors on the outer side, and the pronators and flexors on the inner, should be made evident.

5. The median nerve on the inner side of the brachial artery and the biceps tendon on the outer should be dissected out as well as the anastomoses between the profunda, anastomotica magna, and recurrent branches of the radial and ulnar. The musculo-spiral nerve and its branches at the outer side of the space between the brachialis anticus and supinator longus must be dissected out.

6. Observe the division of the brachial into the radial and ulnar, and the recurrent branches of this latter.

7. Make out the insertion of the brachialis anticus, and dissect out the origins of the flexors and supinators, and pronators and extensors.

SCAPULAR REGION.

1. Make an incision along the lower border of the scapula from the spine to the insertion of the deltoid, and another along the spine of the scapula, then reflect the skin above and below.

2. In the subcutaneous superficial fascia define the acromial branches of the cervical plexus and the cutaneous filaments of the circumflex.

3. Define the aponeurosis of the deltoid and trapezius.

4. Reflect these, and make out the attachments of the muscles to the neighbouring bones.

5. Define the aponeurosis of the supra- and infra-spinatus, and teres major and minor.

6. Reflect the deltoid and dissect out the nerves to it, the posterior circumflex artery and branches, and the accompanying vein.

7. Make out the insertions of the supra- and infra-spinatus and teres minor, defining the triangular and quadrangular spaces between the triceps and teres muscles.

8. Make out the origins of the triceps, then divide the scapulo-humeral muscles, noting any bursæ between them and the shoulder joint or any prolongations from them to strengthen the shoulder capsule.

9. Dissect out the ligaments of the shoulder and the vessels and nerves to the joint, noting its relations; open the joint and observe its articular facets and the synovial sheath of the biceps and the bursæ beneath the subscapularis.

10. Dissect out the acromio-clavicular articulations.

11. Define the supra-scapular artery and nerve, their branches, and the anastomoses of the artery with the other scapular arteries.

BACK OF THE ARM.

1. An incision along the back of the arm about two inches below the elbow joint; transverse incisions if necessary on the outer and inner side of this; and reflect the skin.

2. In the superficial fascia dissect out the subcutaneous veins and the cutaneous nerves from the circumflex, musculo-spiral, and internal cutaneous.

3. Reflect the aponeurosis of the triceps, making out the external and internal intermuscular septa and the structures which pierce them.

4. Make out the three heads of origin of the triceps.

5. Trace out the musculo-spiral nerve and superior profunda artery and their branches and accompanying veins; also the ulnar nerve.

BACK OF THE ELBOW.

1. Dissect out the superficial veins and nerves, the latter coming from the internal cutaneous, the musculo-cutaneous, and musculo-spiral, and observe the subcutaneous bursa over the triceps insertion.

2. Observe the continuation of the deep fascia of the arm with that of the forearm, and note the insertion of the triceps and the close relation between it and the deep fascia.

3. Reflect the triceps, make out the attachments of the anconeus, observe the posterior articular branches of the superior profunda, the posterior branches of the inferior profunda and the anastomotica magna, and dissect out their anastomoses with the posterior ulnar and interosseous recurrents.

4. Define the posterior ligament of the elbow joint.

FRONT OF THE FOREARM.

1. Make an incision from the bend of the elbow to just below the wrist, and transverse ones on the inner and outer sides joining this.

2. In the superficial fascia dissect out the cutaneous, radial, and ulnar veins on the outer and inner sides, and the cutaneous branches of the external and internal cutaneous and musculo-spiral nerves; then reflect it.

3. After observing the deep fascia or muscular aponeurosis, reflect it by a similar incision, noting the origins of the muscles from it at the upper part and the sheaths it forms for them.

4. Observe the long supinator and extensors on the outer side going to the back of the forearm and the flexors and pronators in front.

5. Dissect out the radial and ulnar arteries and branches, and the accompanying veins and nerves.

6. Carefully reflect the tendon of the flexor sublimis, and dissect out the deeper layer of muscles, which are,

7. The flexor profundus, flexor longus pollicis, and pronator quadratus.

8. Make out the common and anterior interosseous branches of the ulnar and the accompanying veins and anterior interosseous nerve from the median; also define the anastomoses between the anterior carpal branches of the radial and ulnar.

9. Observe the attachment of the anterior annular ligament, and note the tendons of the vessels and nerves which pass below and above it.

10. Make out the attachments of the interosseous membrane and the structures which are in relation with and pierce it.

11. Reflect the origins of the flexors and pronators, and make out the attachments and relations of the anterior ligament of the elbow and front of the orbicular ligament.

PALM OF THE HAND.

1. Continue the incision in the mid-line to the tip of the middle finger, and make transverse ones on the outer and inner side at the wrist and webs of the fingers, and reflect the skin of the palm and of the finger.

2. The superficial fascia is thin. Be careful of the palmaris brevis and palmar cutaneous branches of the median and ulnar nerves.

3. Dissect out the attachments of the palmar fascia, and trace its digital processes and vertical septa which divide the palm into three partitions.

4. Make out the superficialis volæ and ulnar arteries forming the superficial palmar arch, also the ulnar nerve, and at the webs of the fingers define the digital arteries, and nerves from the median and ulnar.

5. Carefully reflect the palmar fascia and dissect out the tendons of the flexor sublimis and profundus and their synovial sheaths, and note their mode of insertion into the second and third phalanges, with the various processes accessory to the tendons.

6. Divide the annular ligament in the middle and reflect it, raising the tendons towards the fingers so as to expose the anterior ligament of the wrist, the lumbricales, the deep palmar arch, and the palmar interossei.

7. Dissect out the intrinsic muscles of the thumb and little finger.

8. Define the tendon of the flexor longus pollicis, the muscular branches of the median, and the collateral digital nerves.

9. Follow out the deep or palmar branch of the ulnar artery, anastomosing with the radial to form the deep palmar arch, and note the deep branch of the ulnar nerve accompanying the ulnar artery.

10. Define the origins of the palmar interossei.

PALMAR ASPECT OF FINGERS.

1. Reflect the skin by the median incision, and in the subcutaneous fascia define the collateral palmar digital vessels, nerves, and lymphatics.

2. Reflect the superficial fascia and define the processes, arrangements, and attachments of the flexor tendons, and observe the prolongations of the palmar fascia along the tendinous sheaths.

3. Reflect the sheaths of the tendons by a median incision and lift one tendon from the other, at the same time drawing them towards the finger tip so as to display the attachments of the synovial and fibrous structures accessory to the tendon.

4. Observe the anterior ligaments of the phalanges and metacarpo-phalangeal joints, also their connection with the periosteum of the bones in these parts.

5. Trace out the branches of the deep palmar arch and their anastomoses, and the muscular and articular branches of the median and ulnar nerves.

BACK OF THE FOREARM.

1. An incision continuous with the one already existing along the back of the arm as far as the nail of the middle finger.

2. In the superficial fascia define the cutaneous veins emptying into the radial and ulnar, and the cutaneous nerves from the musculo-spiral, musculo-cutaneous, and internal cutaneous.

3. Make out the attachments of the deep fascia or aponeurosis to the borders of the radius and ulna; reflect this by a median incision, noting the origins of the extensors from it.

4. Define the origins of the extensors, and trace them as far as the posterior annular ligament.

5. Reflect the superficial muscles, and dissect out the origins of the deep and the course of the posterior interosseous nerve and artery.

6. Observe the insertion of the supinator brevis, the anastomoses of the posterior ulnar and interosseous recurrents, and the posterior carpal branches of the radial and ulnar.

7. Define the attachments of the interosseous membrane, and observe the posterior interosseous artery coming to the back above it at the upper part, and the anterior interosseous piercing it just above the pronator quadratus, and note its anastomoses with the posterior carpal arch.

8. Dissect the elbow joint, noting the ligaments, especially the posterior and external and internal lateral; then open it to observe its articular surfaces.

BACK OF THE HAND.

1. Make transverse cuts on the outer and inner side of the median dorsal incision, then reflect the skin from the back of the hand, and by median and lateral cuts from the backs of the fingers and thumb.

2. In the thin superficial fascia dissect out the cutaneous veins, noting the vena salvatella on the little finger and the commencement of the cephalic at the root of the thumb. Observe the cutaneous branches of the radial and ulnar nerves, and trace them to the ends of the fingers.

3. Remove this thin aponeurosis, and observe the tendons of the extensors passing beneath the posterior annular ligaments.

4. Divide this latter structure in the mid-line, note the synovial sheaths of the tendons, and draw the extensor tendons towards the finger ends, observing the attachments of the carpal extensors to the bases of their respective metacarpal bones and the insertions of the extensors of the thumb and digits to the second and third phalanges.

5. Dissect out the radial artery and its branches, the carpal, metacarpal, dorsal interosseous, and dorsal digital arteries and venae comites, and define the origins and insertions of the dorsal interossei.

6. The corpuscles of Pacini should be carefully looked for in the twigs of the dorsal and palmar collateral digital nerves, and the anastomoses between these nerves as well as between their corresponding arteries and veins should be made out.

7. The ligaments and articulations of the wrist, hand, and fingers, and the joint surfaces should now be dissected, and subsequently longitudinal and transverse sections of the bones of the thoracic limb should be made in order to understand their structure and the attachments of the periosteum.

VARIETIES OF THE BONES OF THE THORACIC GIRDLE.

Clavicle.—In about 4 per cent. of cases a deltoid tubercle is present on the upper surface between its outer and middle third. This bone is sometimes perforated by the clavicular branch of the descending cervical plexus. Sometimes there is a prominent ridge at the upper part of the sternal end due to overgrowth of this epiphysis.

Scapula.—A *spina teretis majoris* may be present at the lower part of the axillary border, and a *supra-coracoid tubercle*, or rough surface, may exist at the origin of the long head of the biceps. Occasionally, an *infra-glenoid tubercle* at the seat of the origin of the long head of the triceps exists. Sometimes the acromion is united to the spine by a synchrondrosis, or by a joint, the *articulatio acromialis*. This peculiarity should be remembered so as to distinguish it from a fracture or separation of epiphysis. Occasionally the transverse ligaments become cartilaginous or ossified, and convert the suprascapular notch into a *foramen scapulæ*. The venter sometimes remains cartilaginous, or may be perforated.

Humerus.—At the insertion of the coraco-humeral ligament, just above and to the inner side of the lesser tuberosity, there is often a rounded flat impression or a shallow groove called the *fovea capitis humeri*. Occasionally the twist or torsion of the shaft is much pronounced, and the musculo-spiral groove is deeper than usual.

In a recent number of the 'Revue d'Anthropologie' there is the last memoir of Broca on torsion of the humerus and on the *tropometer*, an instrument for measuring the torsion of bones. This paper includes tables drawn up by Broca and Manouvrier of measurements of the angle of torsion in man and other animals, from which the following conclusions are drawn; viz. that torsion of the humerus attains its maximum in the human species; that the negro is intermediate in this respect as in many others between the superior races of man and the anthropoids, some races of Oceania being, indeed, inferior to the negro in this respect; that the transition from man to the greater anthropoids is insensible—the smallest angle observed in the human species descending even below the smallest angle measured in sixteen humerus bones of the gorilla; that the angle is greater in the gorilla than in the other large anthropoids, and greater in them than in the small monkeys; that the transition from these latter to the carnivora is again almost insensible; that the angle is very large in the ostrich; and that it is almost universally greater in the left humerus than in the right. The coronoid depression is sometimes perforated. Above the internal condyle in about 3 per cent. of individuals a supra-condyloid process exists. This may be completed into a foramen by a fibrous band, or the boundaries of the foramen may be completely ossified. An accessory head of the pronator teres often arises from this process when present, and the brachial artery and median nerve frequently pass through

it, an arrangement which is constant in many Apes, Carnivora, and Marsupials. Prof. Struthers called particular attention to this structure several years ago in the 'British and Foreign Med.-Chi. Review,' 1854, and recently has exhibited his very interesting specimens at the International Medical Congress. He has shown that it is in several cases hereditary. I am indebted to his kindness for the accompanying illustrations.

Radius.—Sometimes the ridge on the dorsal surface of its lower end is much developed, forming a prominence which should not be mistaken for an exostosis.

Ulna.—Sometimes a small ulnar tuberosity is present just below the dorsal portion of the lesser sigmoid cavity, and the cartilage of the greater

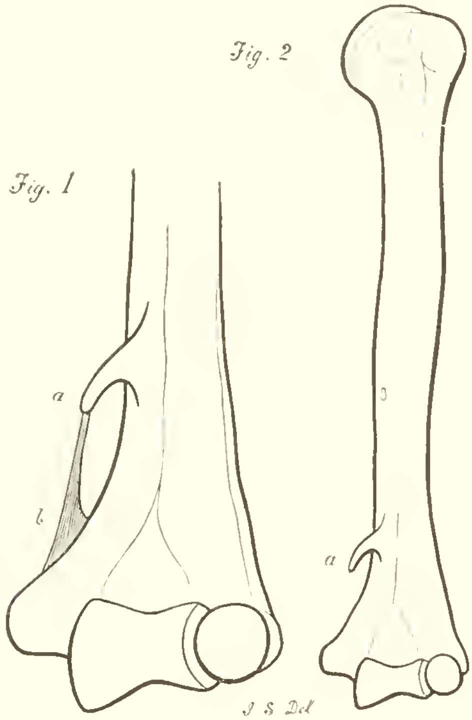


FIG. 226.—THE SUPRA-CONDYLOID PROCESS IN MAN. PROCESS (*a*) AND LIGAMENT (*b*) COMPLETING THE ARCH IN MAN. HALF NATURAL SIZE.

1. The nerve, artery, and venæ comites pass through. 2. One fourth the natural size.

sigmoid cavity is often divided by a rough transverse line, which part of the bone remains uncovered by cartilage.

Carpal Bones.—An *os carpi centrale* is occasionally found between the two rows of bones, and exists normally, according to Henke and Reyher, in the embryo at the eighth week. Some one or other of the carpal bones may, in rare instances, be divided into two parts, the supernumerary portions being called secondary or accessory carpal bones. I have two or three times seen these varieties. Some of these varieties can only be explained on the evolution theory, but the presence of the accessory radiocarpal can be explained by its development, as it is developed by two ossific centres. Exceptionally there are eleven carpal bones, and the magnum is sometimes divided into three pieces, of which one represents, according

to Gruber, the styloid process of the third metacarpal which has become separated. The intermedium has two ossific centres and the two facets usually present at its distal end frequently coalesce.

Metacarpal Bones.—Occasionally the styloid process of the third metacarpal is connected with the os carpi intermedium by a joint.

Sesamoid Bones.—The sesamoid bones of the thumb are absent in about 13 per cent. of cases. The sesamoid of the first joint of the second finger is sometimes on the ulnar and sometimes on the radial side, and is

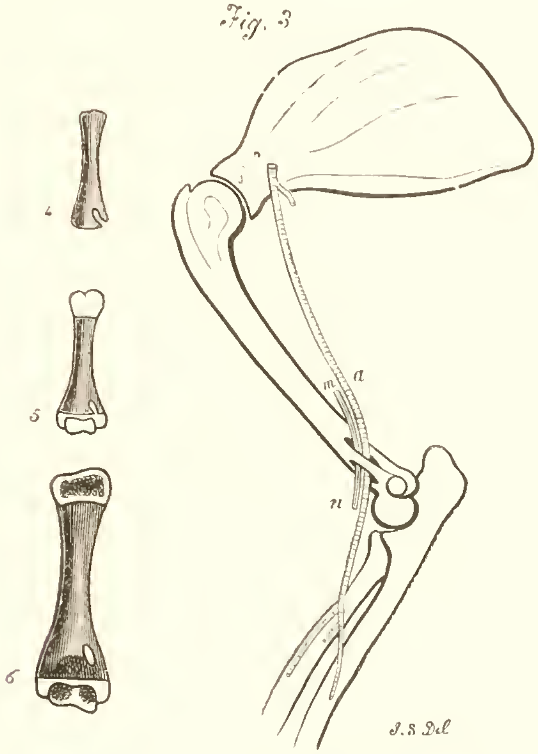


FIG. 227.—THE SUPRA-CONDYLOID PROCESS. FROM FORE-LIMB OF CAT HALF NATURAL SIZE.

The median nerve (*m n*) and brachial artery (*a*) are seen to pass through the foramen. 4, 5, and 6 show the development of the arch in the kitten: 4 and 5 at birth: 6, five weeks later. The half-grown bony arch in the kitten corresponds exactly to the full-length bony process in man.

absent in about 31 per cent. of subjects. The sesamoid of the fifth finger lies on its ulnar side, and is absent in about 19 per cent. of cases. The second finger possesses a sesamoid bone or fibro-cartilage in about 42 per cent. of cases, and the little finger in about 70 per cent.; and they were symmetrical on the right and left sides in 86 per cent. of subjects. Very rarely, a sesamoid bone is found on the first joint of the fourth finger. (Consult the writings of Gruber, W. Krause, Rosenburg, Gillette, Barkow, and Aeby for further particulars upon this subject.)

Summary of Important Facts connected with the Bones of the Shoulder Girdle.

O = ORIGIN. I = INSERTION.

Name of bone	Ligaments attached	Place of their attachment	Muscles attached	Place of their attachment	Bones they articulate with	Ossific centres and date of appearance
Clavicle	Inter-clavicular	Sternal end, upper edge	Subclavius	I. Inferior surface of body	Two. With sternum and acromion process	Two. One for shaft and acromial end about sixth week; the other for sternal end, from fifth to twentieth year. Is the first bone to ossify, and at birth is completely formed, with the exception of the sternal portion
	Acromio-clavicular	Sternal extremity	Sterno-mastoid	O. At sternal end.		
	Rhomboid	Sternal end	Pectoralis major	O. Anterior surface, sternal part		
	Superior acromio-clavicular Inferior acromio-clavicular	Acromial end	Trapezius	I. Acromial part		
	Coraco-clavicular	The tuberosity	Deltoid	O. ,, ,,		
Scapula	Superior acromio-clavicular Inferior acromio-clavicular	Acromion	Serratus magnus	I. Front of base	Two. Clavicle and humerus	Seven. One in body between second and third month. At first year, another for the coracoid. Between fifteenth and sixteenth another for base of acromion. Another for posterior border and inferior angle; and another for the end of the acromion. At seventeen a second centre for base of coracoid. It is completely ossified between the twenty-second and twenty-seventh years
			Pectoralis minor	I. Apex of coracoid process, inner side		
	Coraco-clavicular	Base of coracoid process	Levator anguli scapula	I. Superior internal angle and border		
	Coraco-acromial	Between acromion and coracoid process	Rhomboids	I. To the inner border, the minor being above the major		
			Trapezius	I. The spine and acromion.		
	Transverse	Edges of notch	Omo-hyoid	O. Superior margin		
	Glenoid	Around glenoid fossa	Supra-spinatus	O. Supra-spinous fossa		
	Capsular	Around glenoid fossa and the outer surface of glenoid ligament	Infra-spinatus	O. Infra-spinous fossa		
			Subscapularis	O. Ventral surface and inner border		
			Teres major	O. Posterior surface, inferior angle		
			Teres minor	O. Posterior surface, axillary border		

			[Biceps short head]	o. Outer facet of coracoid process		
			Biceps long head	o. Upper edge of glenoid fossa		
Humerus	Capsular	Anatomical neck	Pectoralis major	I. Outer lip of bicipital groove		Seven. One for shaft, one for head, one for great tuberosity, one for trochlea, one for capitellum, and one for each condyle. The centre for shaft appears in third month, at birth the shaft is ossified. Between first and third years the nuclei for the head appear, then those for the great tuberosity, for the capitellum, and afterwards for trochlea appear. From fourth to fifth year, the nucleus for the lesser tuberosity appears, then that for internal condyle. From sixth to tenth years appears the nucleus for the external condyle, and coalescence of all the nuclei at same period. From fifteenth to thirtieth year, ossification is complete, at first below, and then above
	Coraco-humeral	Great tuberosity	Supra-spinatus	I. Upper facet of great tuberosity	Three. Scapula, ulna, and radius	
	Anterior of elbow	Just above articular surface of lower end				
	Posterior "		Infra- "	I. Middle facet of great tuberosity		
	External lateral	External condyle	Teres minor	I. Lower facet of great tuberosity		
	Internal "	Internal "	Subscapularis	I. Lesser tuberosity		
			Teres major	I. Inner head of bicipital groove		
			Latissimus dorsi	I. Bicipital groove		
			Deltoid	I. Outer surface of shaft at middle		
			Coraco-brachialis	I. Inner surface of shaft at middle		
			Brachialis anticus	o. Anterior surface of front of lower half of shaft		
			Anconeus	o. Back of external condyle		
			Supinator longus	o. Upper two-thirds of external border		
			Supinator brevis	o. External condyle		
			Extensor carpi radialis longior	o. Lower third of external border		
			Extensor carpi radialis brevior Ext. com. dig. " min. " " carp. ulnaris	o. External condyle		
			Pronator teres Palmaris longus Flexor carpi radialis " " ulnaris " digitorum sublimis	o. Internal condyle		

Summary of Important Facts connected with the Bones of the Shoulder Girdle—*continued.*

O = ORIGIN. I = INSERTION.

Name of bone	Ligaments attached	Place of their attachment	Muscles attached	Place of their attachment	Bones they articulate with	Ossific centres and date of appearance
Radius	Oblique	Below bicipital tuberosity	Biceps	I. Back of tuberosity	Four. Humerus, scaphoid, semilunar, and ulna in two places	Three. One for the shaft and one for each end. The shaft centre appears at middle of bone soon after that of humerus. It is ossified at birth but the ends are cartilaginous. From first to third year, nucleus for lower epiphysis appears, and from fourth to fifth, nucleus for upper epiphysis. At puberty, upper end joins shaft, and from twentieth to thirtieth year the lower does the same. In the long bones of the upper limb, union takes place at their upper ends first and then at their lower
	Interosseous	Interosseous ridge, i.e. intl. border	Pronator teres	I. Outer surface of middle shaft		
	Orbicular	Around head	Pronator quadratus	I. Front of lower fourth of shaft		
	Anterior radio-carpal	Front of lower end	Supinator longus	I. Base of styloid process		
	Posterior radio-carpal	Back ,, ,,	,, brevis	I. Ant. and ex. surface of upper third		
	External lateral of wrist	Styloid process	Flexor sublimis dig.	O. Oblique line		
	Anterior inferior radio-ulnar	Front of lower end	,, longus poll.	Front of shaft from tuberosity to pronator quadratus		
	Posterior inferior radio-ulnar	Back ,, ,,				
	Triangular fibro-cartilage	Lower end	Extensor ossis met poll.	O. Back of mid-shaft		
			Extensor primi internodii poll.	O. Back of inner edge of posterior surface below former		

Ulna	Anterior of elbow	Margin of coronoid process	Triceps	I. Olecranon	Two. With the humerus, and radius in two places	Three. One for the shaft, one for olecranon, and one for head. The centre for the shaft appears about fifth week, at birth only ends are usually cartilaginous. At fourth year, the head nucleus appears, and extends into the styloid process, the nucleus for olecranon appears about tenth year, and at sixteenth year the olecranon joins shaft. At twentieth to twenty-fifth year, the lower epiphysis unites with the rest of the bone
	Posterior ,,	Margin of olecranon	Anconeus	I. Outer edge of olecranon and upper fourth of posterior surface above oblique line		
	Internal lateral of elbow	Inner edge of sigmoid cavity				
	External lateral of elbow	Outer margin				
	Orbicular	Front and back edge of lesser sigmoid cavity				
	Interosseous	External border	Extensor carpi ulnaris	O. Middle of posterior surface		
	Anterior inferior radio-ulnar	Front of lower end	Brachialis anticus	I. Base of coronoid process		
	Posterior inferior radio-ulnar	Back ,, ,,	Flexor sublimis digitorum	O. Front of shaft		
	Internal lateral of wrist	Styloid process	Flexor profundus digitorum	O. Inner and posterior surface of shaft		
			Flexor carpi ulnaris	O. Posterior border		
			Extensor indicis	O. Lower end of posterior surface near outer border		
			,, oss. met. pol.	O. Small upper part, posterior surface, near outer border		
			,, secund. int. pol.	O. Posterior surface near outer border		
			Pronator quadratus	O. Front of lower end of shaft		

Carpal and Metacarpal Bones and Phalanges.

IT WILL BE MORE CONVENIENT TO ADOPT A SOMEWHAT DIFFERENT ARRANGEMENT FOR THESE SMALLER BONES.

O = ORIGIN. I = INSERTION.

Name of bone	Ligaments attached	Place of their attachment	Muscles attached	Place of their attachment	Bones they articulate with	Ossific centres and date of appearance
Scaphoid	Between the bones of this row are: Two palmar Two dorsal Two interosseous Anterior of wrist Posterior ,, Anterior intercarpal Posterior ,, Ext. lateral of inter-metacarpal	Corresponding surfaces Palmar surface Dorsal ,, Palmar ,, Dorsal ,, External ,,	Flexor brevis pollicis	o. Tuberosity	Five. The radius above, trapezium and trapezoid below, os magnum and semilunar internally	One for each carpal bone. They are cartilaginous at birth. In the first year the centres for the magnum and unciform appear, the former developing first; in the third year the cuneiform centre is deposited; in the fifth, those for the trapezium and lunar appear, the former preceding the latter. In the sixth year the scaphoid centre appears; in the eighth, the trapezoid, and in the twelfth the pisiform
Semilunar	Between this and the bones given above and below are similar ligaments Anterior of wrist Posterior ,, Anterior intercarpal Posterior ,,	Corresponding surfaces Palmar surface Dorsal ,, Palmar ,, Dorsal ,,			Five. Radius above, magnum and unciform below, scaphoid on outer, and cuneiform on the inner side	
Cuneiform	Between this and the preceding bones are similar ligaments Anterior of wrist Posterior ,, Internal lateral of wrist Anterior intercarpal Posterior ,, Internal lateral of intercarpal Capsular for pisiform	Corresponding surfaces Inner side Palmar surface Dorsal ,, Inner ,, Anterior ,,			Three. The pisiform in front, semilunar outside, and unciform below. It indirectly articulates with the ulna by means of the interarticular fibro-cartilage	

Pisiform	Internal lateral of wrist	Inner side	Flexor carpi ulnaris	Insertion	One. The cuneiform
	Capsular for cuneiform	Posterior edge	Abductor minimi digiti	Origin	
	Piso-unciform	Front surface			
	Piso-metacarpal	,, ,,			
Trapezium	Between the bones of the second carpal row are:		Abductor pollicis	o. Anterior surface	Four. Two carpal and two metacarpal: the former being the scaphoid above and trapezoid inside: the latter being the second metacarpal inside and the first below
	Three dorsal	Corresponding surfaces	Flexor brevis pollicis	o. ,, ,,	
	Three palmar		Opponens pollicis	o. ,, ,,	
	Two interosseous		First dorsal interosseous	o. Posterior ,,	
	External lateral of wrist	Outer side	Flexor carpi radialis	In its groove	
	Anterior intercarpal	Palmar surface			
	Posterior ,,	Dorsal ,,			
	Ext. lateral of intercarpal	External ,,			
	Capsular	Round articular surface			
Trapezoid	Between this and trapezium and magnum are similar ligaments	Corresponding surfaces			Four. Three carpal and one metacarpal, with the scaphoid above, trapezium outside, magnum inside, and second metacarpal below
	Anterior intercarpal	Palmar surface	Flexor brevis pollicis	o. Inner head	
	Posterior ,,	Dorsal ,,			
	Carpo-metacarpal: Dorsal, Palmar	Corresponding surfaces			
Os magnum	Between this and trapezoid and unciform are similar ligaments	Corresponding surfaces			Seven. Four carpal and three metacarpal. The scaphoid and lunar above, trapezoid outside, unciform inside, and with the second, third, and fourth metacarpal below
	Anterior intercarpal	Palmar surface	Flexor brevis pollicis, inner head	o. In front	
	Posterior ,,	Dorsal ,,	Adductor pollicis, inner head	o. ,,	
	Carpo-metacarpal: Dorsal, Palmar, Interosseous	Corresponding surfaces			

Carpal and Metacarpal Bones and Phalanges—*continued.*

It will be more convenient to adopt a somewhat different arrangement for these smaller bones.

O = Origin. I = Insertion.

Name of bone	Ligaments attached	Place of their attachment	Muscles attached	Place of their attachment	Bones they articulate with	Ossific centres and date of appearance
Unciform	Between this and magnum are similar ligaments	Corresponding surfaces	Flexor brevis pollicis, outer head	O. ,,	Five. Three carpal, two metacarpal. The lunar above, cuneiform inside, magnum outside, and fourth and fifth metacarpal below	
			Adductor poll., outer head	O. ,,		
	Anterior intercarpal	Palmar surface	Flexor brevis min. digiti	O. Unciform process		
	Posterior ..	Dorsal ,,	Opponens min. digiti	O. ,, ,,		
	Intl. lateral of intercarpal	Inner ..				
	Carpo-metacarpal: Dorsal, Palmar, Inter-osseous	Corresponding surfaces				
Metacarpal bones			Flexor carpi radialis	I. Base of front of second metacarpal	The first metacarpal with the trapezium at its base and first phalanx of thumb at its head	Two for each bone. One for the shaft and one for the head for the four inner: one for the shaft and one for the base for the metacarpal of thumb, which in this respect resembles the phalanges. The shaft centres appear about the sixth week, and those for the head and base
			Extensor carpi ulnaris	I. Base of back of fifth metacarpal		
			Extensor carpi rad. long.	I. Back of base of second metacarpal	The second metacarpal, with the trapezium, trapezoid, magnum, and three metacarpal at its base, and first phalanx of index at its head	
	The carpo-metacarpal as given with the second carpal row and the		Extensor carpi rad. brev	I. Back of base of third metacarpal		
	Inter-metacarpal: Dorsal, Palmar, Inter-osseous	Corresponding surfaces	Extensor oss. metacarpi poll.	I. Back of base of first metacarpal	The third metacarpal, with the magnum and second and fourth metacarpals at its base, and with the base of the first phalanx and middle finger at its head	
			Opponens pollicis	I. Inner side of head of first phalanx		
			Abductor ,,	I. Outer side of head of first phalanx		
	Metacarpo-phalangeal: Anterior, Two lateral	Palmar surface on each side of joints	Opponens min. digiti	I. Lower end of fifth metacarpal	The fourth, with the magnum, unciform, and third	

					finger at its head	
Phalanges	Interphalangeal Anterior Two lateral	Palmar surface on each side of joints	Flexor longus pollicis	I. Base of palmar aspect of second phalanx of thumb	With each other and with their corresponding metacarpal bone	Two centres. One for the shaft and one for the base. The former appears about the sixth week, and the latter about the fifth year. Union takes place from the seventeenth to the twenty-first year. The centres for the bases appear in the following order: First in the thumb phalanx: secondly, in the middle finger phalanges: thirdly, in the ring finger phalanges: fourthly, in the little finger phalanges, and lastly for those of the index finger
			Flexor brevis pollicis	I. Outer sesamoid at base of first phalanx of thumb		
			Extensor primi int. poll.	I. Base of dorsal surface of second phalanx of thumb		
			Extensor secundi int. poll.	I. Dorsal surface of base of first phalanx of thumb		
			Abductor pollicis	I. The outer sesamoid of base of thumb		
			,, minimi digiti	I. Inner edge of base of first phalanx of little finger		
			Flexor brevis min. dig.	I. Inner edge of base of first phalanx of little finger		
			Flexor sublimis digitorum	I. Base of palmar surface of the four inner fingers		
			Flexor profundus digitorum	I. Base of palmar surface of the third phalanges of same fingers		
			Palmar interossei	I. Two sides of bases of first phalanges of first, third, and fourth fingers near palmar aspect		
			Dorsal ,,	I. Two sides of bases of first phalanges of first, second, and third fingers near dorsal aspect		
			Lumbricales	I. Radial sides of the phalanges of the fingers		

Name	Origin	Insertion	Action
Pectoralis major	Clavicle, sternum, and first to seventh costal cartilages	Humerus, outer bicipital ridge	Adductor of arm elevator of stern and ribs
„ minor	Third to fifth cost. cartgs.	Coracoid proc. of scapula, inner facet	Depresses scapula raises ribs
Subclavius	First costal cartilage	Under surf. clavicle, middle third	Depresses clavicle raises first rib
Serratus magnus	First to ninth ribs	Base of scapula	Draws scapula wards or raises r
Biceps	Long head, glenoid cavity; short head, coracoid process, middle facet	Radial tubercle and deep fascia	Flexor and supina of forearm or presses shoulder
Coraco-brachialis	Coracoid process, outer facet	Middle of front of humerus	Draws arm forwa and inwards
Brachialis anticus	Humerus lower half intermuscular septum	Coronoid process of ulna	Flexor and sli supinator
Deltoid	Clavicle outer half, acromion, and spine of scapula	Humerus, middle of outer surface	Raises arm or depre shoulder
Supra-spinatus	Supra-spinous fossa	Great humeral tuberosity	External rotator arm
Infra- „	Infra- „ „	Middle facet, great tuberosity	External rotator arm
Teres minor	Axillary border of scapula	Lowest facet of great tuberosity	External rotator
Teres major	Inferior angle of scapula	Inner bicipital ridge	Internal „
Latissimus dorsi	Sixth lower dorsal, fifth lumbar, half iliac crest, and four last ribs	Bottom of bicipital groove	„ „ draws arm in backwards
Subscapularis	Subscapular fossa	Lesser tuberosity	Internal rotator
Triceps	Long head: below glenoid cavity, outer head: outer surface of humerus. Inner head: inner surface of humerus	Olecranon process of ulna	Extensor of fore- or depressor of s pula
Pronator teres	Inner condyle of humerus, deep fascia	Middle of outer surf. of radius	Rotates radius inwa
Flexor carpi radialis	Internal condyle, deep fascia	Second metacarpal, palmar aspect	Flexor of hand
Palmaris longus	Internal condyle and fascia	Palmar fascia	Tensor of palmar fa and flexor of har
Flexor carpi ulnaris	Internal condyle, fascia, post. edge of ulna	Pisiform and fifth metacarpal, palmar aspect	Flexes the hand
Flexor sub. dig.	Inner condyle, septum, coronoid process of ulna, and oblique line of radius	Second phalanges of the four fingers, palmar aspect	Flexor of second p langes and then wrist
Flex. long. poll.	Radius, ant. surface, outer half intoss. memb. ulna, coronoid process	Base of last phalanges of thumb, palmar aspect	Flexes second phal and then the thi
Flex. prof. dig.	Ulna, upper two-thirds, inner half intoss. memb.	Third phalanges of the four fingers, palmar aspect	Bends the third p langes, then the ot and the wrist
Pronator quadratus	Ulna, lower ant. fourth	Radius, lower ant. fourth	Rotates the radius
Supinator longus	Supra-condyloid ridge of humerus and intermuscular septum	Base of styloid process of radius	Flexor and supina of forearm

Antagonists	Arteries come from	Veins go to	Nerves	Lymphatics go to
tiss. dorsi, teres major	Ext. mam., intercostals, and perforating	Ext. mam., intercostals, and perforating	Ext. and int. ant. thoracic	Sternal, cervical, and axillary glands
apezius, lev. scap. itercostals	Ext. mam., intercostals, and perforating	Ext. mam., intercostals, and perforating	Int. ant. thoracic	Sternal, cervical, and axillary glands
rno-mastoid, trapezius	Superior and acrothoracic	Ext. mam., intercostals, and perforating	Branch from fifth and sixth of brachial plexus	Cervical glands
omboids or interostals	Long thoracic, subscapular, intercostals	Long thoracic, subscapular, and axillary	Post. thoracic	Axillary glands
ceps, anconeus, nd the two pronators	Muscular of brachial	Brachial	Musculo-cutaneous	,,
ltoid, teres major, nd lat. dorsi	Muscular, ant. circflex.	Axillary	Musculo-cutaneous	,,
ceps, anconeus, nd pronators	Muscular and inf. profunda	Brachial	Musculo-cutaneous and spiral	,,
ct. maj., teres iaj., cor.-brach., t. dors.	Acrom.-thor., and ant. and post. circfx.	Axillary	Circumflex	Axillary and cervical glands
oscap., teres maj., t. dors.	Supra and transverse scapular	Subclavian	Supra-scapular	Axillary glands
oscap., teres maj., t. dors.	Scapular; dorsalis scap.	Axillary	,,	,,
oscap., teres maj., t. dors.	Scapular; dorsalis scap.	,,	Circumflex	,,
pra- and infrapinatus, teres ninor	Posterior scap. and dors. scapulæ	,,	Subscapular	,,
ct. maj., coracorach.	Lumbar intercostal; subscap.	Correspondingly named vein	Long subscapular	,,
pra- and infrapin., ter. maj.	Subscapular	Axillary	Subscapular	,,
eps and brach. nt.	Subscapular, sup. and inf. profunda	Brachial	Musculo-spiral	,,
pinator brevis	Muscular of ulnar and radial	Venæ comites	Median	,,
tensors carpi uln. id. long. and brev.	Muscular of ulnar and radial	Brachial	,,	,,
tensors carpi uln., id. long. and brev.	Muscular of ulnar and radial	,,	,,	,,
tensors carpi uln., id. long. and brev.	Muscular of ulnar and radial	,,	Ulnar	,,
tensor com. dig.	Muscular of ulnar and radial	,,	Median	,,
tensor long. poll.	Ant. intoss.	,,	Ant. interosseous	,,
,, ,,	Intoss., med., and muscular of ulnar	Brachial through radial	Ant. intoss. and ulnar	,,
pinator brevis	Ant. and post. interosseous	Ulnar and interosseous	Ant. intoss.	,,
ceps, anconeus, nd pronators	Sup. prof. and radial	Radial and brachial	Musculo-spiral	,,

Name	Origin	Insertion	Action
Ext. carp. rad. long.	Lower third supra-condyloid ridge of humerus, and intermuscular septum	Dorsal surface of base of second metacarpal	Extends and abdu the hand
„ „ brev.	Ext. condyle and deep fascia	Dorsal surface of base of third metacarpal	Extends and abdu the hand
Ext. com. dig.	Ext. condyle and deep fascia, but below it	Bases of dorsal surface of second and third phalanges	Extends the fingers
Ext. min. dig.	Ext. condyle and intermuscular septum	Dorsal surface of second and third phalanges	Extends the lit finger
Ext. carp. ulnaris	Ext. condyle and deep fascia	Dorsal surface of base of fifth metacarpal	Extends and addu the hand
Anconeus	Ext. condyle and deep fascia, below former	Upper third of ext. surf. of ulna	Extensor of forearm
Supinator brevis	Humerus, ext. condyle; ulna below lesser sigmoid cavity; also from ext. lateral and orbicular ligaments	Radius above oblique line	External rotator
Ext. ossis metcarpi. poll.	Middle of post. surface of radius. Middle of post. surface of ulna and from intoss. memb.	Dorsal surface of base of thumb metacarpal	Extends and abdu the thumb
Ext. primi intnod. poll.	Back of lower part of radius and intoss. membrane	Dorsal surface of base of first phalanx of thumb	Extends first phala
Ext. sec. intnod. poll.	Back of lower part of ulna and intoss. membrane	Dorsal surface of base of second phalanx of thumb	„ second „
Ext. indicis	Back of lower part of ulna and intoss. membrane, below former	Blends with index tendon of communis	Extends index fing
Palmaris brevis	Palmar fascia	Skin of inner side of [palm	Wrinkles skin of pa
Lumbricales	Radial side of tendons of flex. prof. dig.	Radial side of ext. com. dig.	Flex first phalanx
Abd. min. dig.	Pisiform and tendon, flex. carp. uln.	Inner side of first phalanx of little finger	Abducts little finge
Flex. brev. min. dig.	Unciform process and annular ligament	Inner side of base of first phalanx of little finger	Bends the first phala
Abd. min. dig.	Unciform and annular ligament	Inner side of base of first phalanx of little finger	Abducts little finge
Abd. poll.	Trapezium and annular ligament	Outer side of base of first phalanx and outer sesamoid	Abducts the thum
Opponens poll.	Trapezium and annular ligament	Radial side of base of first metacarpal	Opposes thumb to lit finger
Flex. brev. poll.	Trapezoid, magnum, and middle metacarpal	Inner and outer sides of base of first thumb phalanx and two sesamoids	Flexes the first phal
Add. poll.	Magnum and base of middle metacarpal	Inner side of base of first thumo phalanx and inner sesamoid	Adducts the thum
Palmar interossei (three)	Between second, fourth, and fifth metacarpals	Ulnar side of first phalanx of second finger, and radial side of fourth and fifth fingers	Draw second, fou and fifth fingers middle finger
Dorsal interossei (four)	Adjacent sides of the metacarpals	Bases of first phalanges of first, second, and third fingers, and to extensor tendon	Separate the finger

Antagonists	Arteries come from	Veins go to	Nerves	Lymphatics go to
carp. ulnaris	Sup. prof. and radial	Radial and brachial	Musculo-spiral	Axillary glands
,,	,, ,,	Radial and brachial	Posterior intoss.	,,
com. dig.	Radial recurrent, posterior intoss.	Radial and brachial	,,	,,
min. dig.	Post. interossei	Post. interossei	Post. interossei	,,
carp. radialis	Post. intoss. and radial recurrent	,,	,,	,,
and brach.	Radial recurrent	Radial	Musculo-spiral	,,
tors	Post. intoss.	Post. intoss.	Post. intoss.	,,
tor poll.	,,	,,	,,	,,
s of thumb	,,	,,	,,	,,
,,	,,	,,	,,	,,
exors	,,	,,	,,	,,
—	Ulnar	,,	Ulnar	,,
om. dig.	Deep palmar arch	Radial and ulna	Median and ulnar	,,
ssei	Ulnar	,, ,,	,, ,,	,,
in. dig.	Ulnar, deep branch	Deep arch	Ulnar	,,
terossei	,, ,,	,,	,,	,,
tor poll.	Superficialis volæ, palmar interosseous and first digital	,,	Median	,,
ors poll. long. brev.	Deep branch of ulnar	Superficialis volæ and deep arch	,,	,,
ors poll. long. brev.	,, ,,	Superficialis volæ and deep arch	Median and ulnar	,,
oll. and extrs of thumb	First digital and first two palmar interossei	Deep arch	Ulnar	,,
interossei	Palmar interosseous	,,	,,	,,
,,	Dorsal interosseous and metacarpal	Radial, ulnar, and interosseous	,,	,,

Anastomoses of Upper Limb.

Region	Anastomosing arteries
Thorax	The perforating of internal mammary from subclavian with long thoracic of axillary. Muscular and long thoracic with first to twelfth intercostals from thoracic aorta. Superior and acromio-thoracic with first intercostal
About shoulder joint	The acromio-thoracic of axillary with acromial branch of suprascapular from subclavian. Suprascapular of subclavian with transverse cervical from same source
Scapula	Subscapular of axillary with posterior scapular from subclavian and dorsalis scapulæ of subscapular with posterior scapular. Long thoracic with subscapular
Arm	Acromio-thoracic of axillary with anterior circumflex of brachial. Anterior and posterior circumflex of brachial with subscapular of axillary, and muscular with each other
Around elbow joint	Superior profunda of brachial with the recurrent of radial, inferior profunda of brachial with anterior ulnar recurrent. Anastomotica magna with ant. and post. ulnar recurrent and posterior interosseous recurrent
Around wrist joint	Anterior and posterior carpal of radial and ulnar with each other and with ant. and post. interosseous of ulnar above, and carpal arch below
Metacarpus	Superficialis volæ of radial with ulnar, and deep branch of ulnar with radial. The palmar interossei of the deep arch with dorsal interossei from the metacarpal of radial
Phalanges	The palmar digitals from the superficial arch with the dorsal digitals from the metacarpal or dorsal interossei of radial

Synovial Sheaths of Tendons and Muscular Bursæ of Upper Limb.

Around Shoulder and in Arm.

1. Under tendon of subscapularis.[1]
2. ,, ,, infra-spinatus.[1]
3. Beneath deltoid (multilocular bursa).
4. Around tendon of long head of biceps.[1]
5. Between ,, latissimus dorsi and teres major.

At Elbow.

1. Beneath tendon of triceps.
2. ,, ,, biceps.

Around Wrist.

1. Around tendon of palmaris longus.
2. ,, tendons of flexors sublimis and profundus.[2]
3. ,, tendon of flexor longus pollicis.
4. ,, ,, ,, carpi radialis.
5. ,, ,, ,, ,, ulnaris.
6. ,, tendons of the three extensors of thumb.
7. ,, ,, ,, two ,, carpi radialis.
8. ,, ,, of extensor communis and indicis.[2]
9. ,, tendon of ,, minimi digiti.

[1] These usually communicate with the joint. That for the infra-spinatus is inconstant.
[2] These may, though extremely rarely, communicate with the wrist joint.

FINGERS.

Along the tendons of the superficial and deep flexors; the synovial sheaths of the thumb and little finger are prolongations of the sac which surrounds the flexors at the wrist, but there are variations in the arrangement of these sheaths as described in the text.

Subcutaneous Bursæ which are Normal and Constant.

IN UPPER LIMB.

1. Over acromion.
2. ,, epitrochlea.
3. ,, epicondyle.
4. ,, olecranon.
5. ,, styloid process of radius.
6. ,, ,, ,, ulna.
7. ,, dorsal surface of metacarpo-phalangeal joints.
8. ,, palmar ,, ,, ,, ,,
9. ,, dorsal ,, interphalangeal joints.

Bursæ which are Normal but Inconstant.

1. Over the convex part of clavicle.
2. ,, lower angle of scapula.
3. Between latissimus dorsi and ribs.

CHAPTER V.

THE LOWER LIMB.

DISSECTION OF THE THIGH.

THE FRONT AND INNER SIDE OF THIGH AND FEMORAL HERNIA.

Instructions.—The body being on its back, with a block under the loins, and the buttocks having been brought to the edge of the table, the student should rotate the leg out, and support it in a semiflexed position by resting the foot on a stool.

External Markings and Boundaries.—The thigh is shaped like a truncated cone, with its base above at the hip, which forms the root of the lower limb, and its apex below at the knee. It is rounded, with a slight flattening at the outer side, and a depression at the upper and inner part. It is limited in *front and above* by the ligament of Poupart or Fallopius, which extends from the spine and crest of the pubis to the anterior superior iliac spine, and forms the fold of the groin ; on the *outer side and behind* by the iliac crest, and sacrum, and coccyx ; on the *inner side* by the rami of pubis and ischium. Below the limit of the thigh is the inter-articular line of the knee. On the upper and inner aspect of the thigh is a slight hollow, which corresponds with Scarpa's triangle, and along the middle of this the femoral artery runs obliquely to the inner side of the limb. A line from a little internal to the centre of Poupart's ligament, to the internal condyle of the femur, marks the position of the artery. The *common* femoral artery can be compressed sufficiently by directing the pressure up and backwards, and the *superficial* femoral is controlled by pressing outwards against the femur.

With the thigh slightly flexed, besides the groove forming the bend of the groin, there is a second one below it, which begins at the angle between the scrotum or labium and thigh, and passing outwards, is gradually lost between the top of the great trochanter, and the anterior superior iliac spine. This groove is practically important, as it runs across the hip-joint capsule, is obliterated by effusion into the joint, is tender on deep pressure at its outer part in hip mischief, and is the line along which the knife should be introduced, from without inwards, in antero-posterior flap disarticulation by transfixion at the hip. Along these folds the *inguinal* and *femoral* lymphatic glands may be felt, the former following the line of Poupart's ligament, the femoral, that of the saphena vein, and lying over the saphenous opening and around the femoral vessels. In a thin body, if the fingers be pressed deeply in the hollow, below and at the middle of

Poupart's ligament, and the thumb behind and rather above the great trochanter, the head of the femur can be felt rotating.

At the knee, the patella may be seen and felt in front of the joint, with a depression on either side of it. These become distended and the patella floated up when there is fluid in the knee-joint. In the flexed position this bone is fixed, but when the knee is extended it is easily moved as the triceps is relaxed. The projections of the inner and outer condyles of the femur and their tuberosities can also readily be felt, the former being the larger.

At the *back* of the thigh, at its upper part, the fold of the buttock is noticeable. This is not usually so well marked in men as in women, there being more subcutaneous fat which renders the skin more pendulous. Above, and to the inner side of this fold, the tuber ischii is to be felt. At the *back* of the knee is a slight hollow corresponding to the popliteal space, and at its sides may be felt the tendons of the leg flexors, which help to form its boundaries. Between the upper and lower parts extend the hamstring muscles. At the *upper* and *inner* part of the thigh may be seen and felt the crest, spine, and rami of the pubis, and the tendon of the adductor longus; while at the upper and outer part, the origins of the sartorius, rectus, and tensor fasciæ femoris may be made out in moderately thin subjects.

On the *outer side* of the thigh at its *upper* part there is a depression about four inches below and behind the anterior superior iliac spine; and here the great trochanter can be easily felt, especially if the thigh be rotated. Between the bone and the skin is the fascial insertion of the gluteus maximus, with a bursa underneath it and another superficial to it.

The spines of the pubis and ilium, the tuber ischii, and the great trochanter are valuable surgical landmarks, as they can usually readily be made out. The position of the trochanter major having already been indicated, it remains to consider the relations of it to the bony parts just named, and its differences of relation in the chief movements of the thigh.

The top of the trochanter corresponds to a line (called Nélaton's line) drawn from the anterior superior spine of the ilium to the most prominent part of the tuber ischii, and is nearly level with the spine of the pubes, and about three-quarters of an inch lower than the top of the head of the femur. The line from the trochanter to the tuber ischii runs through the centre of the acetabulum. This is most true when the femur is flexed nearly to a right angle and slightly adducted. The acetabulum is placed, with respect to the surface, in the centre of these three bony projections; viz. the anterior superior iliac spine, the pubic spine, and the tuberosity of the ischium. In fractures of the neck of the femur, or in dislocations of its head, this line is of great value in distinguishing the kind of injury. It is also a guide in subcutaneous division of the neck of the bone.

The length of the lower limb is usually measured from the anterior superior spine of the ilium to the tip of the inner malleolus, but the pubic spine may also form the starting-point. Firm pressure or jerking percussion with the balls of the thumbs on the iliac spines will aid us in examining for fracture of the pelvis, or in sacro-iliac disease. In muscular subjects, in whom there is little subcutaneous fat, the ilio-tibial band on the outer side in the fascia lata may be made out, and also the depressions on the

outer and inner portions of the lower third of the thigh, corresponding to the external and internal intermuscular septa, which separate the muscles on the front from those on the back of the thigh.

Dissection.—Make an incision about four inches long, and only through the skin, from the pubes along the inner side of the thigh; from the upper end of this make one along Poupart's ligament, and from its lower end add another transversely outwards over the thigh. This piece of skin is to be reflected outwards, and then the student may commence the study of the following parts which are comprised in this dissection; viz. the skin, superficial fascia, deep fascia or fascia lata, superficial and deep vessels, muscles and nerves, lymphatic vessels and glands, and the hip-joint.

The skin is fine and smooth on the inner side, and covered with hairs. On the outer side it is coarser. It is very adherent at Poupart's ligament,

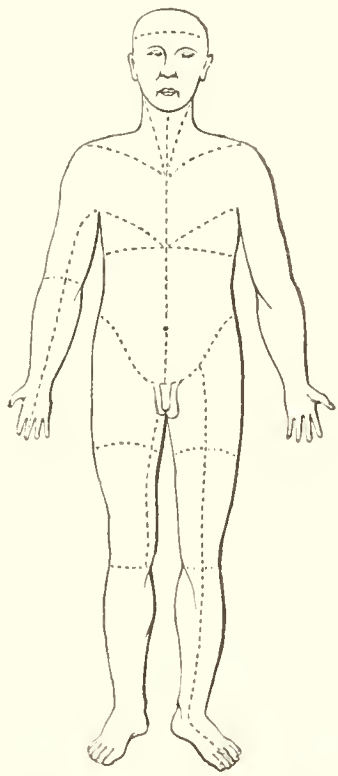


FIG. 228.—DIAGRAM OF INCISIONS FOR DISSECTING THE FRONT OF THE BODY.

but freely movable at other parts. It contains a great number of sebaceous follicles.

The *Superficial Fascia* is a part of the general covering of the body, and is continuous with that of the abdomen above, and scrotum or labium and perineum, and with that on the spermatic cord and round ligament. It varies, with regard to the amount of fat deposited in it, in different subjects, and at the groin is divisible into two layers, a *superficial and deep*, between which are some cutaneous vessels and lymphatic glands.

Dissection.—Reflect the superficial layer by similar incisions to those on the skin, with the exception of the lower incision, which must be two inches higher up. Then commence dissecting it from below upwards.

The internal saphena vein is beneath it, and its under surface has a membranous aspect. In the middle of the space the two layers are easily separated, because of the vessels and glands, but at the inner and outer borders the dissection is not so readily made. Near Poupart's ligament this layer, with the contained fat, becomes thinner and more fibrous. From the under surface of the skin, fibrous filaments pass to Poupart's ligament, and cause the crease of the groin. Now clear away the fatty tissue from the superficial vessels and nerves, and lymphatic glands, without destroying the deep layer of the superficial fascia beneath them. This latter is most marked on the inner side of the mid-vertical line of the thigh. The large vein called the *internal saphena* is near the middle of

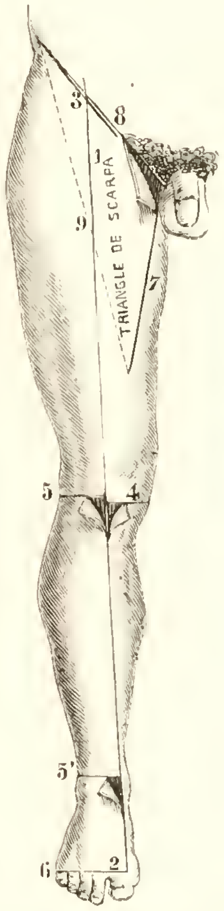


FIG. 229.—DIAGRAM OF INCISIONS FOR DISSECTING THE FRONT OF THE LOWER LIMB.

the space, and of the superficial branches of the femoral artery, two run inwards, and two out, accompanied by their veins. On the inside of the saphena vein, near the pubes, is the ilio-inguinal nerve, and the crural branch of the genito-crural is on its outer side, and the external cutaneous nerve perforates the deep fascia near the anterior iliac spine. Some lymphatic vessels may be seen passing between the inguinal and femoral glands.

Superficial Vessels.—These are branches of the common femoral artery. The two running inwards are the superior and inferior pudic, and those running outwards are the superficial circumflex, and the superficial

epigastric. They all pierce the fascia lata to reach the glands and skin above it which they supply.

The *Superior* or *Superficial External Pudic Artery* is the more super-

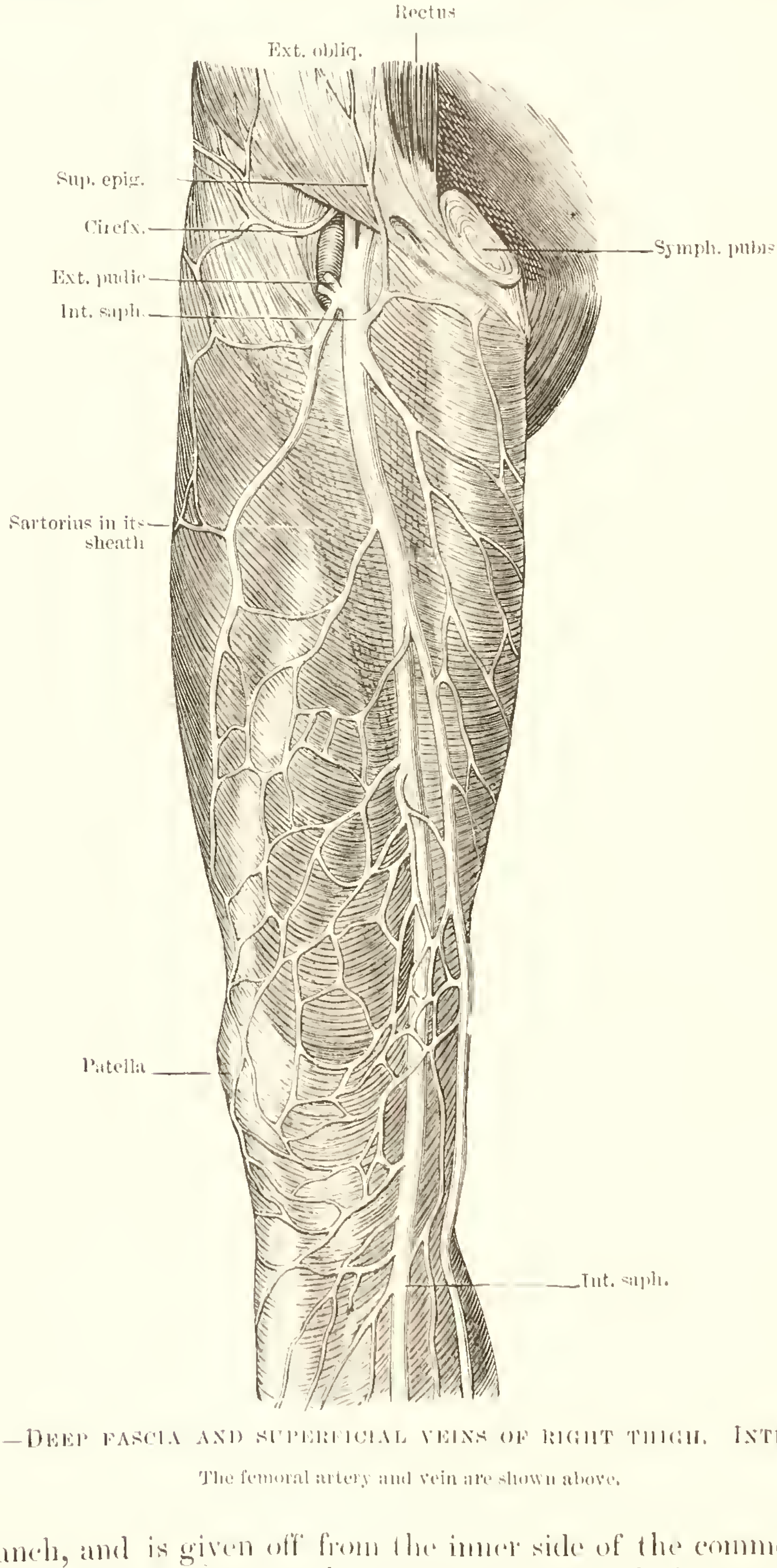


FIG. 230.—DEEP FASCIA AND SUPERFICIAL VEINS OF RIGHT THIGH. INTERNAL VIEW.
The femoral artery and vein are shown above.

ficial branch, and is given off from the inner side of the common femoral, and runs up and in, crossing the external abdominal ring and the sper-

matic cord in the male, and supplies the skin of the lower part of the abdomen and of the penis, and scrotum or labium. It is given off either separately or by a common trunk with the inferior, and pierces the fascia at the saphenous opening, and anastomoses with the superficial perineal branch of the internal pudic, which latter is a terminal branch of the anterior trunk of the internal iliac.

The *Inferior* or *Deep External Pudic* is more deeply seated, passes

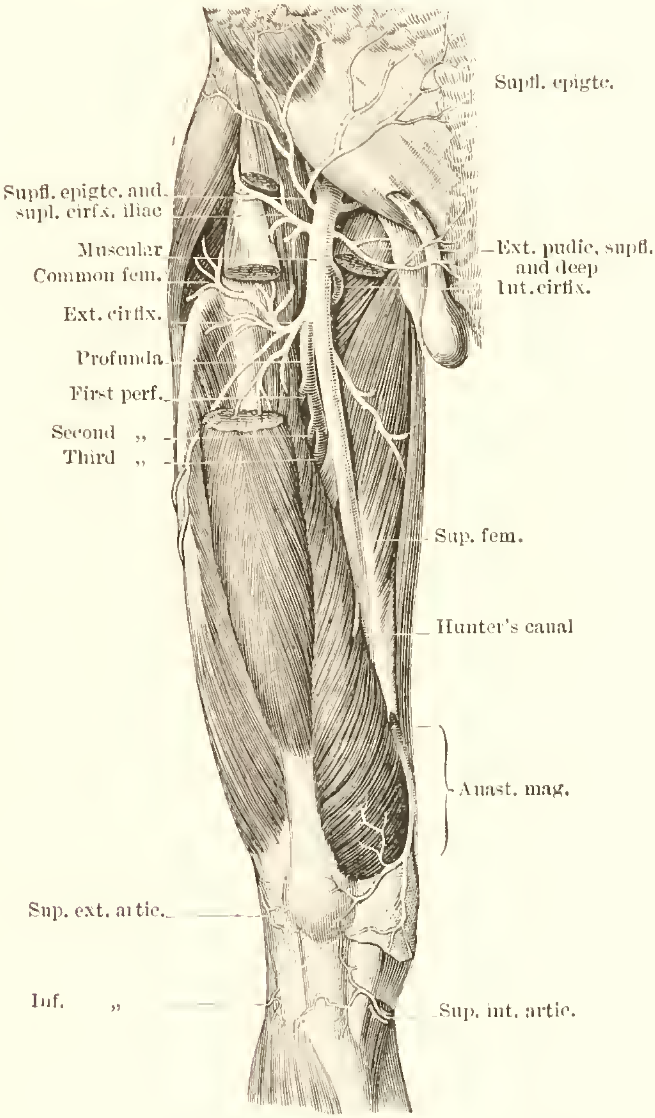


FIG. 231.—RIGHT FEMORAL ARTERY AND BRANCHES.

The deep epigastric and circumflex iliac are seen just below Poupart's ligament, the former passing up and in, and the latter up and outward. The sartorius, rectus, and adductor longus are cut and reflected.

inwards over the pectineus, pierces the fascia lata at the inner border of the thigh, supplies the skin of the scrotum or labium and of the perineum, and joins branches of the superficial perineal artery of the internal pudic.

The *Superficial Epigastric* arises from the front of the femoral, half an inch below Poupart's ligament, passes forwards, up, and inwards,

through the saphenous opening, then lies on the superficial abdominal fascia over the external oblique muscle, and reaches nearly to the umbilicus. It anastomoses with the deep epigastric from the external iliac, and with the internal mammary of the subclavian. These inosculations are of great importance in re-establishing the circulation after ligature of the superficial femoral.

The *Superficial Circumflex Iliac*, the smallest of these branches, is

FIG. 232.—SUPERFICIAL LYMPHATICS AND INGUINAL GLANDS OF THE LEFT LOWER LIMB. INTERNAL ASPECT.

given off from the outer side of the artery, and after crossing and supplying the psoas and iliacus muscles, runs outwards parallel with Poupart's ligament, and pierces the fascia lata at the outer border of the thigh near the iliac crest. Its branches supply the skin, superficial fascia and glands, and join the circumflex iliac branch of the external iliac artery, and the external circumflex branch from the profunda femoris. An offset accom-

panies the external cutaneous nerve. One or two veins, bearing the same names, accompany each artery, and end in the internal saphena vein, except the inferior external pudic vein, which usually directly joins the femoral vein.

The *Lymphatic Glands and Vessels*.—The glands with a few connecting lymphatic vessels are readily dissected, but the lymph vessels of any part of the body—the thoracic duct excepted—are very difficult to trace unless previously injected, and even then they require extremely careful dissection. After describing the glands it will be well to give a *resumé* of the lymphatic vessels of the lower limb, and the student should try and make out the larger ones.

The *Superficial Glands* vary much in number and size. There are generally from eight to fifteen, and often the longitudinal set along the saphena vein are united. They are situated just under the skin in the superficial cellulo-fatty fascia, in a triangular manner, the base being above and the apex below. They may be divided into four groups according to their position: 1, the *supero-internal* group runs parallel with Poupart's ligament, and receives the lymphatics of the anus, perineum and skin of the penis, scrotum and labium; 2, the *supero-external* group also is parallel with the fold of the groin—it receives the lymph vessels of the buttock; 3, the *inferior* group runs parallel with the saphena vein and receives the greater number of the lymphatics of the surface of the lower limb—these are generally larger than the upper groups; 4, the *median* group is placed in the middle of the triangle—it receives the lymphatics of the abdominal wall which accompany the cutaneous veins. These glands become enlarged or inflamed in affections of the parts from which they return the lymph. The *efferent* vessels of the surperficial glands perforate the cribriform fascia and the fascia lata, join the deep lymphatics, pass into the abdomen by the side of the femoral vessels, and joining a set along the external iliac artery, end in the lumbar glands. The upper groups are called *inguinal*; the lower, the *femoral* glands. The deep glands are small, are under the fascia lata, and surround the femoral vessels. The student will observe them when dissecting out these latter.

The *Lymphatic Vessels* of the lower limb are arranged in a *superficial and deep* set and into an *inner and outer* group.[1] They are provided with valves, which occur more frequently than in the veins. The *superficial internal* vessels arise from the dorsum, inner side, and sole of the foot, forming an arch on the dorsum with the outer set, which arch receives the lymphatics of the toes. They then pass before and behind the internal malleolus, running up in the course of the internal saphenous vein, along the inner side of the leg, then behind the internal condyle, up the inside and front of the thigh and end in the femoral glands. The *superficial external* vessels arise from the outer side of the dorsum and sole of the foot, ascend in front of the outer malleolus and leg, and cross obliquely just below the

[1] For extensive and minute information on the subject of lymphatics generally, consult the magnificent recent works of Sappey and of Key and Retzius. Dr. Klein's work is also very good, but it does not deal with the human subject, and is largely pathological. Mascagni, Cruikshank, Teichmann, His, and Recklinghausen are also great authorities. Dr. and Mrs. Dr. Hoggan have recently written on the lymphatics of muscle and skin in the *Proceedings of the Royal Society*, and Dr. Curnow has lately given some good lectures at the College of Physicians on the lymphatics and their diseases.

FIG. 233. SUPERFICIAL LYMPHATICS AND INGUINAL GLANDS OF THE RIGHT LOWER LIMB AND LOWER PART OF ABDOMINAL WALL.

front and back of the knee to join the inner ones of the thigh. Some of these lymphatic vessels pass behind the outer malleolus, accompany the external saphenous vein, and pass between the heads of the gastrocnemius to empty themselves into the popliteal glands. From the middle of the back of the thigh, lymphatics pass on the outer and inner sides, to debouch into the inguinal and femoral glands.

The *Deep Lymphatics* of the foot, leg, and thigh accompany the deep blood-vessels, are few—three or four to each artery—and consist of three sets named after the vessels which they accompany, viz. anterior tibial, posterior tibial, and peroneal, and enter the popliteal glands. Sometimes a small gland is found near the anterior tibial artery on the front of the interosseous membrane above the middle of the leg, and then the anterior tibial set of lymphatics may pass through it, but usually neither the deep nor superficial absorbents enter any gland in the leg, but the deep, after receiving the lymphatics which accompany the branches of the femoral artery, run up around the femoral vein and enter the deep femoral glands, i.e. those around the femoral vessels. In inflammation of the foot and leg, dark red tender lines show the position of these vessels. They very rarely become varicose.

Dissection.—Reflect the deep layer of the superficial fascia by incisions similar to those through the skin, and be careful of the vessels and nerves. The handle of the scalpel will be useful in effecting the separation.

The *Deep Layer of the Superficial Fascia* is a thin membrane containing little fat, and is most developed on the inner side of the saphena vein and near Poupart's ligament. It is separated from the superficial layer by the cutaneous vessels and glands, and is continuous with the deep layer of abdominal fascia. It is firmly adherent to the lower edge of Poupart's ligament, to the body and ramus of the pubes, and to the fascia lata, with which it becomes blended about three inches below the groin. About an inch below Poupart's ligament it covers and partially fills up the saphenous opening, to the circumference of which it is attached externally by fibrous bands, but internally by loose connective tissue. It is also connected with the anterior layer of the sheath of the femoral vessels. The portion of this deep layer which stretches over the saphenous opening has many apertures for small blood-vessels and lymphatics, and is called the *cribriform fascia.* There are two main sets of fibres in the fascia cribriformis; one set is oblique from without down and in from the falciform process, the other runs down and out. These are attached to the spine of the pubes, to the pectineal crest and to Gimbernat's ligament. A complete femoral hernia or rupture has this as one of its coverings. Fluid effused between the superficial and deep layers may extend up on to the abdomen, and down and round the limb, and even *into* the abdomen through the inguinal canal and *vice versa*; but if extravasated under the deep layer it cannot reach the abdomen in consequence of its attachment to Poupart's ligament unless this be ulcerated through. It may get through the openings in the cribriform fascia, then along the femoral vessels into the pelvis and down the thigh, but this is rare.

Dissection.—Make a vertical incision through the skin only, along the middle of the front of the thigh to the tubercle of the tibia; and another, a transverse one, at the lower end of this across the leg, and reflect the flaps in and out (see fig. 229). A subcutaneous bursa over the patella,

and perhaps another over the tibial tubercle, will be opened in doing this. Now clean the saphenous vein, as far as it is exposed, being careful of some branches of the internal cutaneous nerve, and of the internal saphe-

FIG. 231.—CUTANEOUS NERVES OF THE FRONT OF THE RIGHT LOWER LIMB.

The anterior tibial usually supplies the adjoining sides of the great and second toes. The dotted lines represent the nerves before they pierce the deep fascia. A cutaneous artery is shown outside the external cutaneous nerve at the groin.

nous nerve, which are near it; then seek the various cutaneous nerves and trace them up to where they pierce the fascia lata, and note the small cutaneous vessels which accompany them, and which are given off from the

femoral or some of its branches. The superficial branch of the anastomotica magna of the femoral accompanies the internal saphenous nerve near the knee.

The **Cutaneous nerves**, which are more numerous on the inner side, come from the lumbar plexus. They are the internal saphenous, internal and middle cutaneous from the anterior crural; the ilio-inguinal and genito-crural from the first lumbar, and the external cutaneous from the second lumbar nerve. Their relative position is shown in the accompanying figure.

Some twigs also from the anterior crural pierce and cross the anterior layer of the femoral sheath and go to the skin on the upper and inner side of the thigh, after passing through the saphenous opening.

The **Ilio-Inguinal Nerve** comes from the first lumbar; it is small, and its lower part runs with the spermatic cord in the inguinal canal, which it leaves through the external abdominal aperture, to supply the scrotum or labium, and upper and inner part of the thigh internal to the saphenous vein. It is sometimes small, and then the ilio-hypogastric furnishes a branch with a similar distribution. In rare cases it is entirely absent. It joins the inferior pudendal nerve of the small sciatic from the sacral plexus.

The **Genito-Crural Nerve** is a branch of the second lumbar, and has a few fibres from the loop between it and the first. The branch now to be dissected is the external or crural branch which passes beneath Poupart's ligament and pierces the fascia lata a little external to the femoral artery, and is distributed to the skin of the upper part and front of the thigh about half-way down. It joins the outer branch of the middle cutaneous either before or after it has become cutaneous. Under Poupart's ligament it gives some filaments which are prolonged on the femoral artery and which must be sought when that vessel is dissected. Sometimes this branch is larger than usual, and then it replaces the external cutaneous nerve.

The **Middle Cutaneous Nerve** comes from the anterior crural, and runs down the centre of the thigh between the nerves just described. It pierces the fascia lata, and sometimes the sartorius, from three to four inches below the ilio-pubic band, i.e. Poupart's ligament, either as one trunk which soon separates into two branches, or as two branches which have separated before piercing the fascia. These branches run side by side down the thigh as far as the inner side and front of the patella, supplying the skin of these parts by numerous branches. Either before or after it becomes superficial its *outer* branch communicates with the genito-crural. Its *inner* branch joins the anterior branch of the internal cutaneous, and also the internal saphenous nerve near the skin. The sartorius is supplied by this or by the internal cutaneous nerve. Sometimes this nerve arises from the anterior crural high in the abdomen.

The **External Cutaneous Nerve**, or *External Musculo-cutaneous*, comes from the second lumbar, or from the loop between it and the third, and passes under Poupart's ligament beneath the anterior superior iliac spine in a ridge of the fascia lata. It divides into two nearly equal-sized branches, viz. anterior and posterior.

The *Anterior Branch*, the continuation of the nerve, pierces the deep fascia about four inches below Poupart's ligament, and runs as far as the

knee, giving off anterior and posterior branches. The chief filaments are on the outer and posterior surfaces. When it reaches quite to the knee, it joins the internal saphenous and helps to form the plexus patellæ or præ-patellæ, it also joins the outer branch of the middle cutaneous to form the plexus patellæ.

The *Posterior Branch* pierces the fascia about an inch below Poupart's ligament and divides into two or three filaments, which turn back and out to supply the skin from the upper border of the ilium to near the

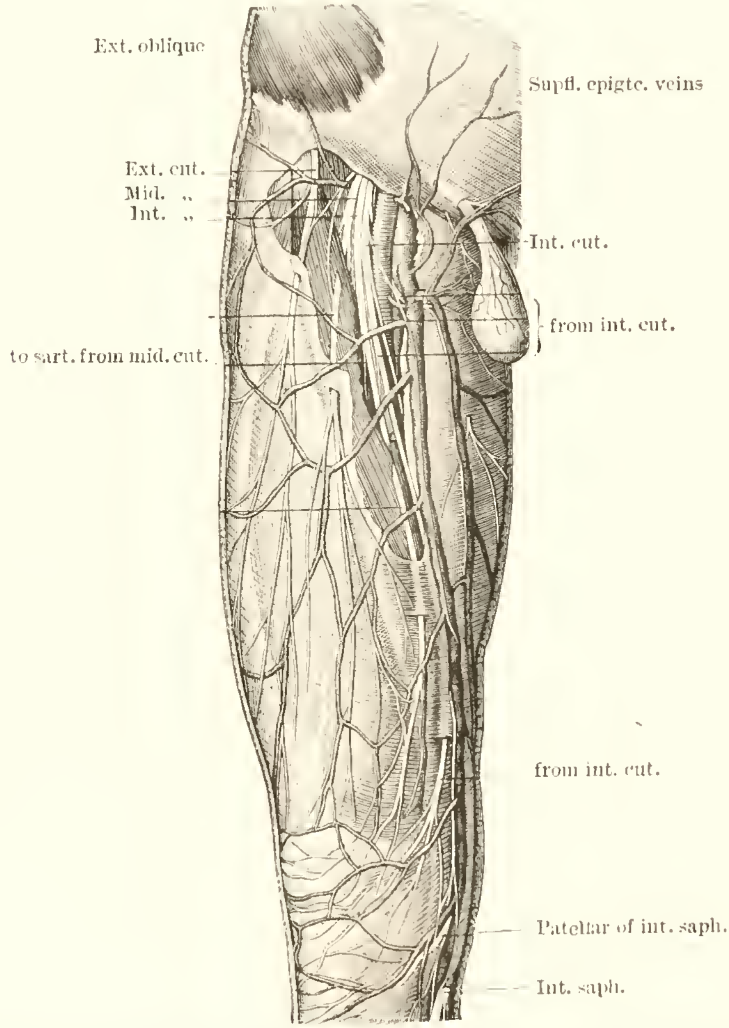


FIG. 235. CUTANEOUS NERVES AND VEINS OF RIGHT THIGH.

Part of the deep fascia removed to expose the anterior crural nerve and femoral vessels. The latter mostly entering int. saph.

middle of the thigh. Its branches are crossed by the cutaneous branches from the last dorsal nerve.

The **Internal Cutaneous Nerve,** from the anterior crural crosses obliquely inwards over the upper part of the femoral artery and divides either in front or to the inner side of it, into an anterior and internal branch which pierce the deep fascia at different levels. It supplies all the inside of the thigh and the upper part of the leg. Before dividing, it gives off two or three twigs which pierce the fascia lata to supply the skin

on the inside of the thigh, accompanying the saphena vein. In some subjects, these small filaments arise directly from the anterior crural, and they frequently join with each other. The topmost filament passes through the saphenous opening and reaches to the middle of the thigh, another larger than the rest appears about the middle of the thigh near the vein extending as far as the knee, and a third pierces the fascia at its lower third.

The *Anterior Branch* perforates the fascia in the lower third of the thigh, and divides into two branches, the *inner* of which runs down near the internal intermuscular septum and supplies the skin over the lower third of the thigh and inner side of the knee, and joins the inner branch

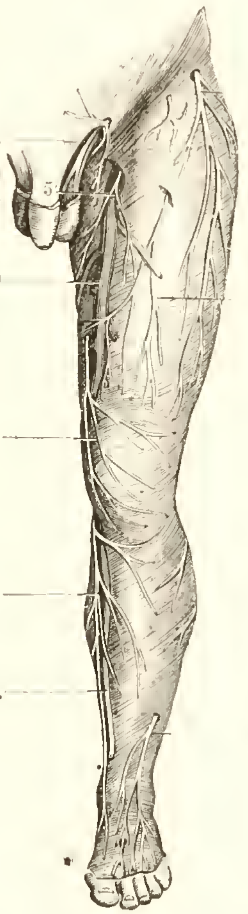


FIG. 236.—CUTANEOUS NERVES OF THE FRONT OF THE LEFT LOWER LIMB PIERCING THE DEEP FASCIA.

of the middle cutaneous; the *outer* one crosses the patella and joins the patellar branch of the long or internal saphenous nerve above the joint, and sometimes takes its place. Occasionally, the internal cutaneous is above the fascia in its whole length, and sometimes it gives off a filament which accompanies the saphenous vein and may join the internal branch now to be described.

The *Internal Branch* runs along the posterior border of the sartorius, pierces the fascia at the inner side of the knee, gives off several cutaneous filaments to the lower and inner side of the thigh, and joins by a small branch the internal saphenous which here lies in front of it. It also

supplies the skin of the inner side of the leg as far as its middle, where it joins the internal saphenous nerve again. Beneath the fascia in the lower third of the thigh, and at the lower border of the Adductor longus, this branch joins in a plexiform network—the *femoral plexus*—with branches of the long saphenous and anterior or superficial branch of the obturator nerve. If this branch of the obturator be large and continued to the skin of the leg, the inner branch of the internal cutaneous is small, and either ends at the plexus, or sometimes also gives off a few cutaneous filaments. It will be noted that the internal cutaneous nerve enters into two plexuses; by its anterior branch with the præ-patellar plexus, and by its internal branch with the femoral plexus. Sometimes one or both of these branches pierce and supply the sartorius.

The **Internal** or **Long Saphenous Nerve** is the largest branch of the anterior crural and is sub-fascial as far as the knee. It runs close to the outer side of the femoral vessels, and, in Hunter's canal, crosses in front of them to the inner side as far as the adductor opening, where it quits the vessels and passes beneath the sartorius to the inner side of the knee. Here it gives off, near the inner condyle, a branch to the skin over the patella and becomes subcutaneous by perforating the fascia between the tendons of the sartorius and gracilis. It then accompanies the long saphena vein to the inside of the leg and foot, and joins the internal cutaneous in the thigh and leg.

The *Communicating Branch* of this nerve is given off about the middle of the thigh; this joins the anterior branch of the internal cutaneous and anterior of obturator in the femoral plexus.

Its *Patellar Branch* is large when present, and pierces the sartorius and fascia lata and passes over the front of the patella to join the inner branch of the middle cutaneous and the anterior branch of the external cutaneous to form the plexus patellæ. The internal saphenous is sometimes given off from one of the muscular branches of the anterior crural, and in some subjects it again joins the obturator and internal cutaneous after it has left Hunter's canal.

Dissection.—The dissector should now trace the larger cutaneous veins of the front of the thigh and follow them to the long saphenous. He must then clear away the superficial fascia, fat, and inguinal glands, and reflect the cutaneous nerves which will subsequently be traced to the anterior crural.

Veins of the Lower Limb.—These, like those of the upper limb, are divisible into a superficial and deep set. The deep set run in pairs below the knee, and are named the *venæ comites* of the arteries they accompany. All the veins have valves, and they are more numerous than in the upper limb. The valves are more numerous in the deep than in the superficial veins—ten or twelve being found between the heel and knee. The deep will be described further on.

The *Superficial Veins* commence in a network, which forms an arch on the dorsum of the foot that receives the venules from the toes. From the inner side of this arch issues the internal saphena, and from the outer the external saphena veins. The long saphena vein passes up in front of the internal malleolus along the inner side of the leg, then behind the inner femoral condyle and along the inner side and front of the thigh through the saphenous opening of the fascia lata, and enters the

femoral vein about an inch and a half below the ilio-pubic ligament. This vein is joined in the foot by the internal plantar, and in the leg by the posterior tibial veins, by branches which perforate the tibial head of the soleus. It also communicates with the anterior tibial veins, receives some articular branches at the inner side of the knee, and in the thigh, one or more branches pass between it and the femoral vein. The cutaneous veins of the thigh empty themselves into it near the saphenous opening by two or three large trunks formed by the veins from the outer,

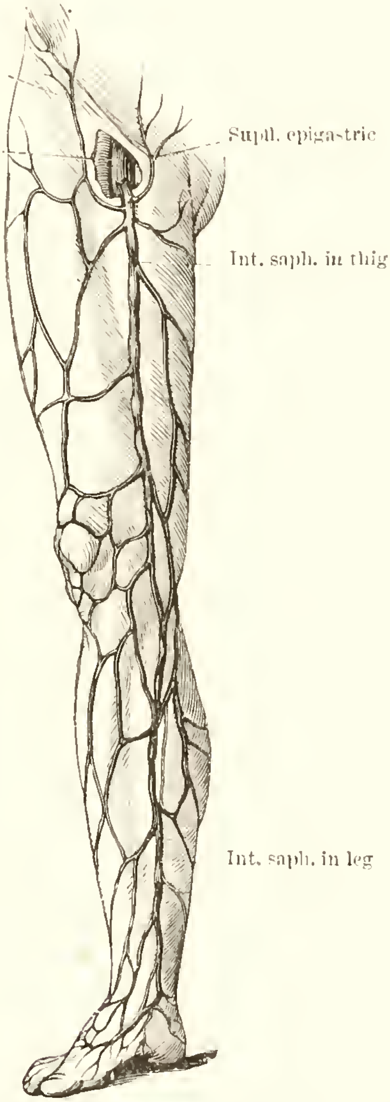


FIG. 237.—RIGHT INTERNAL SAPHENA VEIN AND ITS TRIBUTARIES.

inner, and posterior surfaces. Near its termination it receives the superficial epigastric, superficial circumflex iliac, and superior external pudic. Its valves vary from two to six, and there are more in the thigh than in the leg. The external saphenous vein will be dissected with the leg.

Dissection.—The fascia lata must now be cleaned, especially at the upper part. On removing the deep layer of the superficial fascia the *Saphenous opening* of the fascia lata will be seen. Its outer semilunar edge is to be separated from the superficial fascia, and from the anterior

layer of the sheath of the femoral vessels, the inner side is readily shown. The saphenous vein, called so because it is evident on the surface of the fascia, joins the femoral vein through the lower part of this opening. The cribriform fascia is very adherent to the saphena vein and is somewhat funnel-shaped if the vein be pulled downwards. In studying this fascia the student must first thoroughly understand how it forms the saphenous opening, and then observe its various processes and septa. Pinch up with the forceps the sheaths of the muscles formed by it, and divide and separate each in the course of its fibres, displacing the muscles as little as possible.

The *Deep Fascia* or *Femoral Aponeurosis* (more correctly *apomyosis*) is generally a strong, blueish-white, glistening membrane, whose fibres

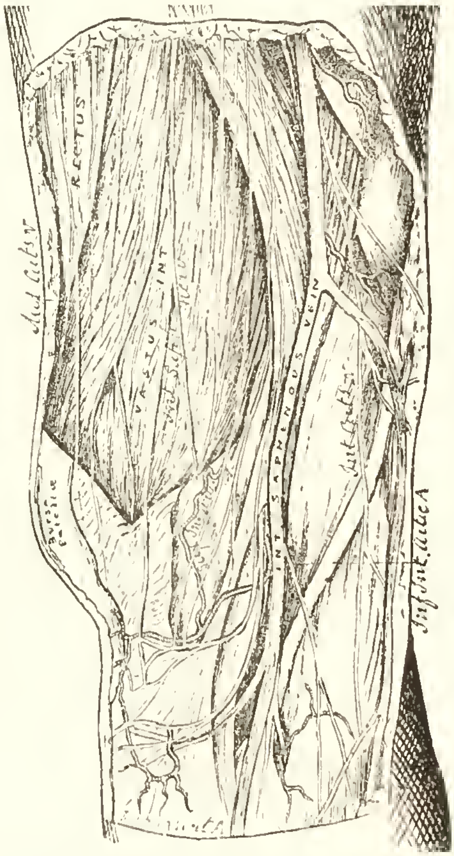


FIG. 238.—SUPERFICIAL DISSECTION OF INSIDE OF RIGHT KNEE, SLIGHTLY ALTERED FROM GODLEE.

interlace in various directions. It continuously surrounds the muscles and vessels, &c., of the thigh, and sends from its under surface, septa between the muscles, and also two strong processes which are attached to the outer and inner lips of the linea aspera, and which separate the muscles in front from those on the posterior and inner aspect of the thigh, giving partial origin to them. The position of these septa is visible on the surface of the fascia by white lines. This membrane, which from its extent is called the *fascia lata*, is thin in very fat subjects. There is another and less strong septum which isolates the inner and posterior groups of muscles.

The fascia lata is much stronger on the outer and upper side of the

thigh than elsewhere, and its *superficial or outer* part is attached above and in front to the crest and spine of the pubes and to Poupart's ligament, and behind it is attached to the outer lip of the crest of the ilium and to the lower part of the posterior surface of the sacrum and coccyx. The *deep part* of the fascia lata is attached to the body and ramus of the pubes, to the ramus and tuberosity of the ischium, and to the ilio-pectineal line, in front of the insertion of the aponeurosis of the external oblique. It covers the pectineus, having over this muscle a thickening of transverse fibres passing from the spine of the pubes to the ilio-pectineal

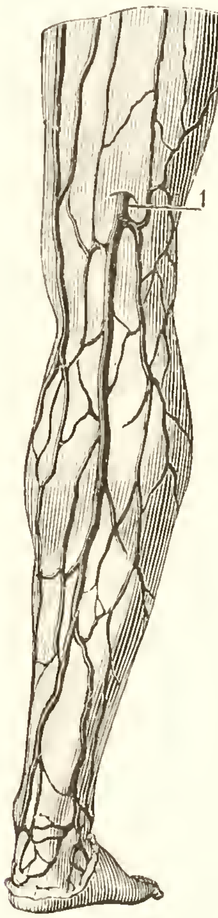


FIG. 239.—RIGHT EXT. SAPHENA VEIN AND ITS TRIBUTARIES.

1. External saphena vein piercing the deep fascia.

line and to the posterior border of Gimbernat's ligament. This is called the *ligament of Cooper*. Most of these fibres come from the lower end of the *ligament of Colles*, which is formed by the most internal fibres of the internal or superior pillar of the external abdominal ring. These fibres are part of the aponeurosis of the external oblique muscles and decussate behind the linea alba with those of the opposite side, to become continuous with the ligament of Cooper. This layer then joins the pelvic fascia through the fascia iliaca, and splits at the inner border of the psoas, investing the lower portion of it and the iliacus, and is attached to the front of the capsular ligament of the hip. At the outer side, the gluteus maximus is inserted into it by a fibrous expansion, and the fascia here encloses

the tensor fasciæ femoris. A strong process passes up between it and the vastus externus, and is attached superiorly to the ilium just above the origin of the posterior head of the rectus. This strong process, called the *ilio-tibial band* or *ligament*, passes down to be attached around the knee to the condyles of the femur, tuberosities of the tibia, and head of the fibula. It relieves the extensor muscles of the knee in standing. Around the knee the fascia lata is strong and receives expansions from the flexor and extensor muscles of the knee. Attached to the sides of the patella are two transverse bands of fibres; the *retinacula* or *alæ* of the patella, of which the outer is stronger than the inner. The former joins the insertion of the vastus externus, and externally, the ilio-tibial band. It pulls the patella outwards in flexion. The inner is fixed to the patella at a lower level, and joins the insertion of the vastus internus. These bands support the patella and strengthen and protect the joint.

This fascia is perforated in numerous places by cutaneous vessels and nerves. Its posterior part will be described in the dissection of the buttock and back of the thigh. To explain the formation of the saphenous opening, and to facilitate the description, this fascia has been artificially divided into an *outer*, *iliac* or *superficial* portion, and an *inner*, *pubic* or *deep* part. The former is external to the saphena vein and the latter internal to it. They will be described in the next sections. If fluid be effused beneath the fascia lata, it can only reach the surface through the apertures in the saphenous opening, or along the cutaneous vessels and nerves, or by ulcerating through the fascia itself. Fluid can pass down as far as the knee and around the thigh, being limited by the intermuscular septa. It may pass into the pelvis along the sheath of the femoral vessels, and *vice versâ*, fluid may pass into the thigh from the cellular tissue of the abdomen and pelvis. The adhesions of the inner and outer parts of the fascia lata to the back and front of the femoral sheath would tend to prevent this, but it does occur occasionally.

ANATOMY OF FEMORAL HERNIA.

Dissection.—To prevent the parts drying, bring together the skin over the front of the thigh, and study the formation of the saphenous opening.

The **Saphenous opening**, or **External Femoral Ring or aperture**, is the lower weak point through which a *complete* femoral hernia protrudes. Before entering into a description of the structures concerned in this hernia, a few explanatory words will render the subject more interesting and intelligent to the student. A *hernia*, commonly called a rupture, is the protrusion of a viscus, or part of it, from its natural cavity; thus, we see hernia cerebri, hernia of the iris, ovary, &c. But the most common form of hernia is protrusion of intestine or of omentum, and this may occur in the inguinal, femoral, or umbilical regions, through the obturator foramen or through the sciatic notch [1]

There may also occur the rare lumbar hernia, i.e. protrusion in the

[1] Lumbar, vaginal, and retro- or post-peritoneal herniæ are rare forms. The first protrudes at the weak part of the loin external to the quadratus lumborum, the second into the vagina, and the third behind the peritoneum. A perinæal hernia may also occur.

lumbar region; sciatic and obturator herniæ are also very rare. The other three kinds are common, inguinal being the most frequent, then femoral, and lastly, umbilical. Femoral and umbilical are more common in women,

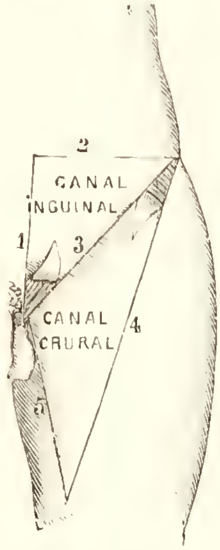


FIG. 240.—DIAGRAM OF INCISIONS FOR THE DISSECTION OF FEMORAL AND INGUINAL HERNIA.

The numbers indicate the course of the incisions.

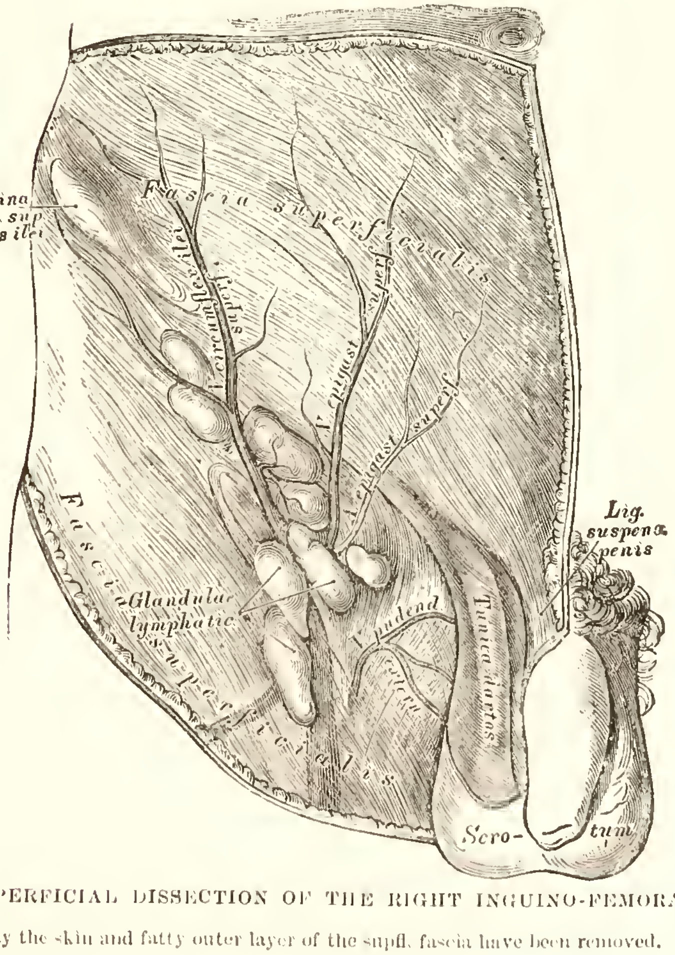


FIG. 241.—SUPERFICIAL DISSECTION OF THE RIGHT INGUINO-FEMORAL REGION.

Only the skin and fatty outer layer of the supfl. fascia have been removed.

and inguinal in men.[1] In women the greater size of the deep femoral ring, the greater depth of the crural arch, and child-bearing, are the predisposing elements for the two former kinds, whereas the descent of the testes distending the canal is said to be the cause of the inguinal canal being a weak point in man. Inguinal and femoral hernia may be *complete* or *incomplete*; when complete they traverse both apertures—external and internal—of their respective canals, and appear under the skin. The *incomplete* forms do not come out of the external rings.

The student must clearly understand that these so-called canals and

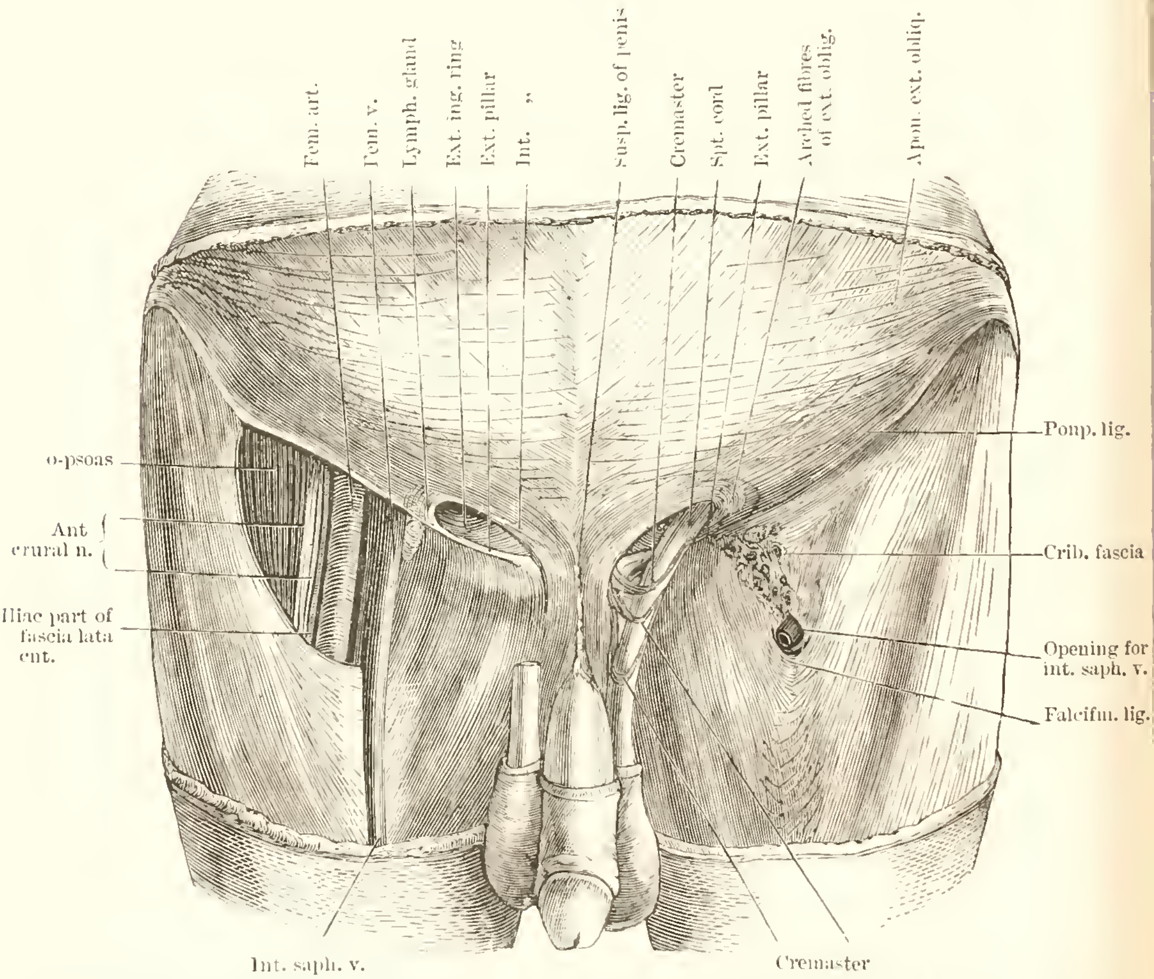


FIG. 212.—SUPERFICIAL VIEW OF THE INGUINAL AND FEMORAL CANALS ON THE LEFT SIDE AND DEEPER DISSECTION ON THE RIGHT SIDE.

The right spermatic cord is cut.

rings are merely weak points in the inguinal and femoral situations, and do not distinctly exist until made by a hernia, or in dissecting. Most intestinal herniæ have *sacs* formed by the peritoneum, and they are mostly *external* as distinguished from *internal* herniæ, which occur inside the abdomen.

Femoral and inguinal herniæ have this in common, that there is a canal and two apertures, but femoral hernia protrudes *below* Poupart's

[1] Inguinal is the common form of hernia in infants and children, and its varieties will be explained in the dissection of the abdomen.

ligament and does not pass into the scrotum or labium, while complete inguinal hernia does. Much confusion is caused to the student by the indiscriminate use of the terms crural and femoral in the description of this hernia. Crural comes from *crus*, which signifies the leg, and is not applicable to this region, which is the *femoral*. We shall, therefore, only call them the femoral canal and rings, and femoral sheath, septum, and arches.

The *Saphenous Opening* results in consequence of the *iliac* portion of the fascia lata being on a plane anterior to the *pubic* portion. The former being attached to Poupart's ligament is in front of the femoral vessels and

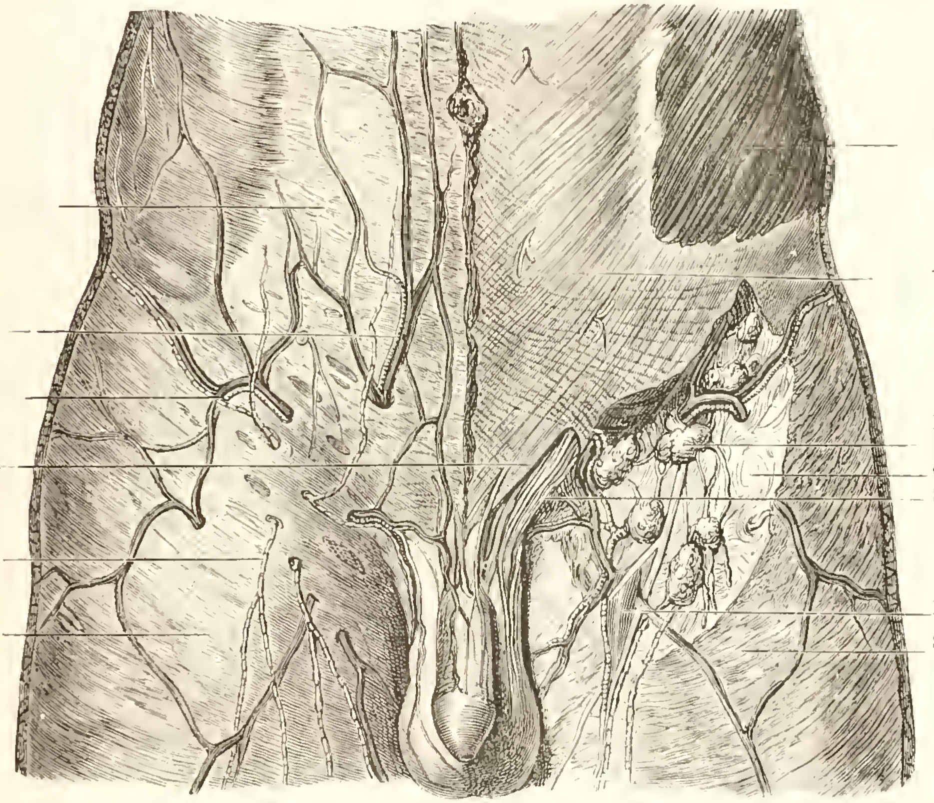


FIG. 243.—SUPERFICIAL DISSECTION OF FEMORAL AND INGUINAL REGIONS.

The ilio-inguinal and hypogastric nerves are shown; also the internal cutaneous of thigh.

their containing sheath, and the latter behind, being attached to the ilio-pectineal line and continuous with the pelvic fascia, so that that part of the deep layer of the superficial fascia which covers the opening and is called the *cribriform* fascia, slants from without inwards in consequence of the outer margin of the opening being on a higher level than the inner.

The **Saphenous Opening,** or **Superficial or External Femoral Ring or aperture,** is the lower and larger aperture of the femoral canal, and is an oval aperture at the upper and inner part of the thigh, and is directed obliquely down and outwards. It is about an inch and a half long and about half an inch wide. Its outer margin or edge is sickle-shaped, and therefore called the *falciform process* of the opening, or superior cornu, and extends from

the spine of the pubes and pectineal line and base of Gimbernat's ligament to the saphenous vein, under which it is continuous with the inner margin of the opening. It passes in *front* of the femoral vessels and is adherent to the *anterior* layer of the femoral sheath, and to the deep layer of the superficial fascia. The concavity of this process is directed down and in. It was described by Allen Burns as the *falciform ligament* or *process*, and is called by some Burns' ligament. The outer and upper part of the saphenous opening is in front of the inner part of the femoral sheath and canal.

The *Inner Margin* of the opening has a thin sharp border, but is less defined than the outer, being stretched over the subjacent pectineus mus-

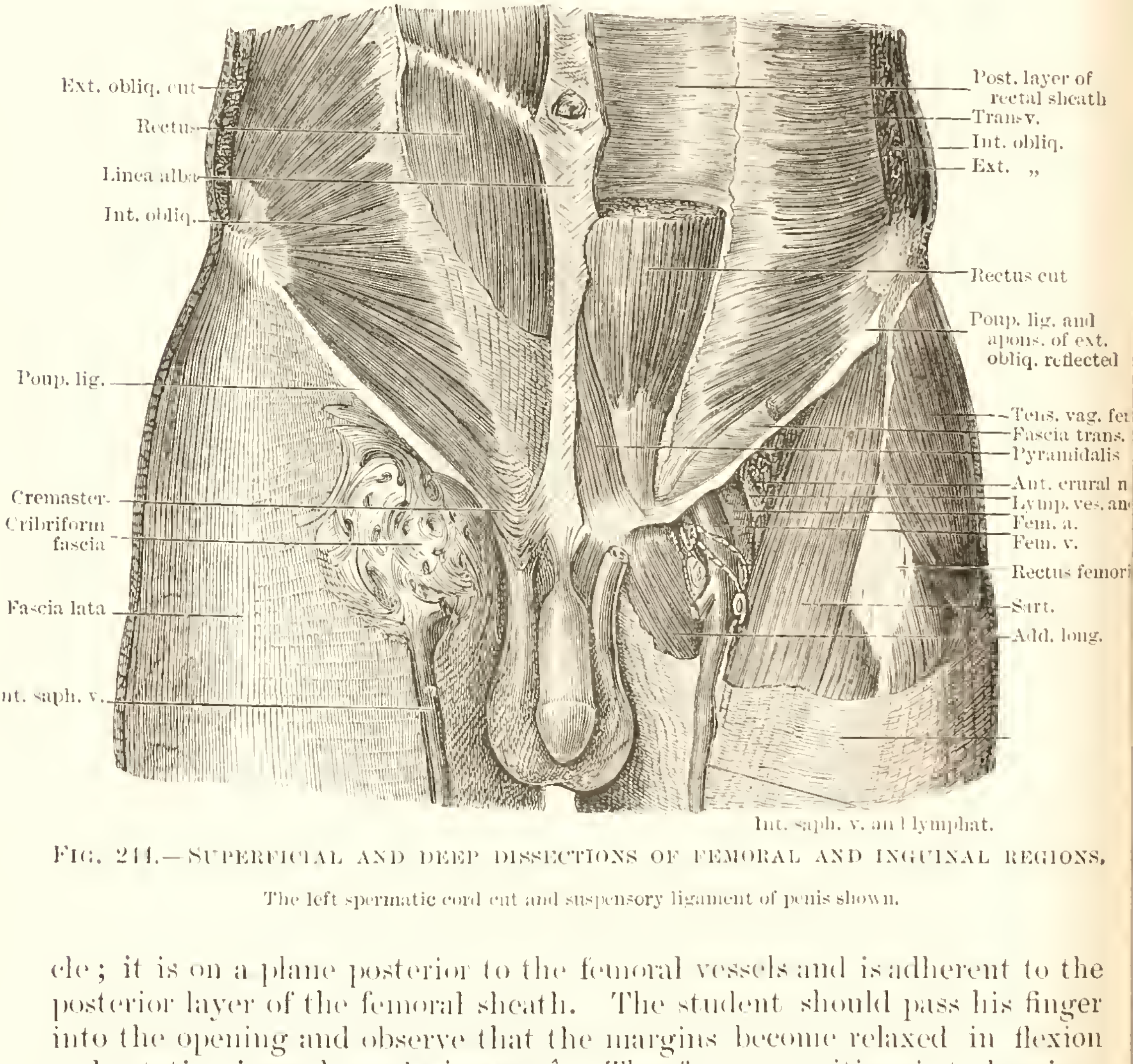


FIG. 244.—SUPERFICIAL AND DEEP DISSECTIONS OF FEMORAL AND INGUINAL REGIONS.

The left spermatic cord cut and suspensory ligament of penis shown.

cle; it is on a plane posterior to the femoral vessels and is adherent to the posterior layer of the femoral sheath. The student should pass his finger into the opening and observe that the margins become relaxed in flexion and rotation inwards, and *vice versâ*. The former position is to be given to the limb in employing the taxis, which is the manipulation employed in attempting to return a hernia into its natural cavity. A hernia does not come out through the lower part of the opening because it is occupied by the saphena vein around which the cribriform fascia is very adherent, but it projects at the upper part of the opening just below the falciform process.

Dissection.—Make an incision through the fascia lata parallel and close

to Poupart's ligament commencing just outside the upper part of the saphenous opening, and passing outwards about two inches; from the termination of this, make another down and in, near to the saphenous vein,

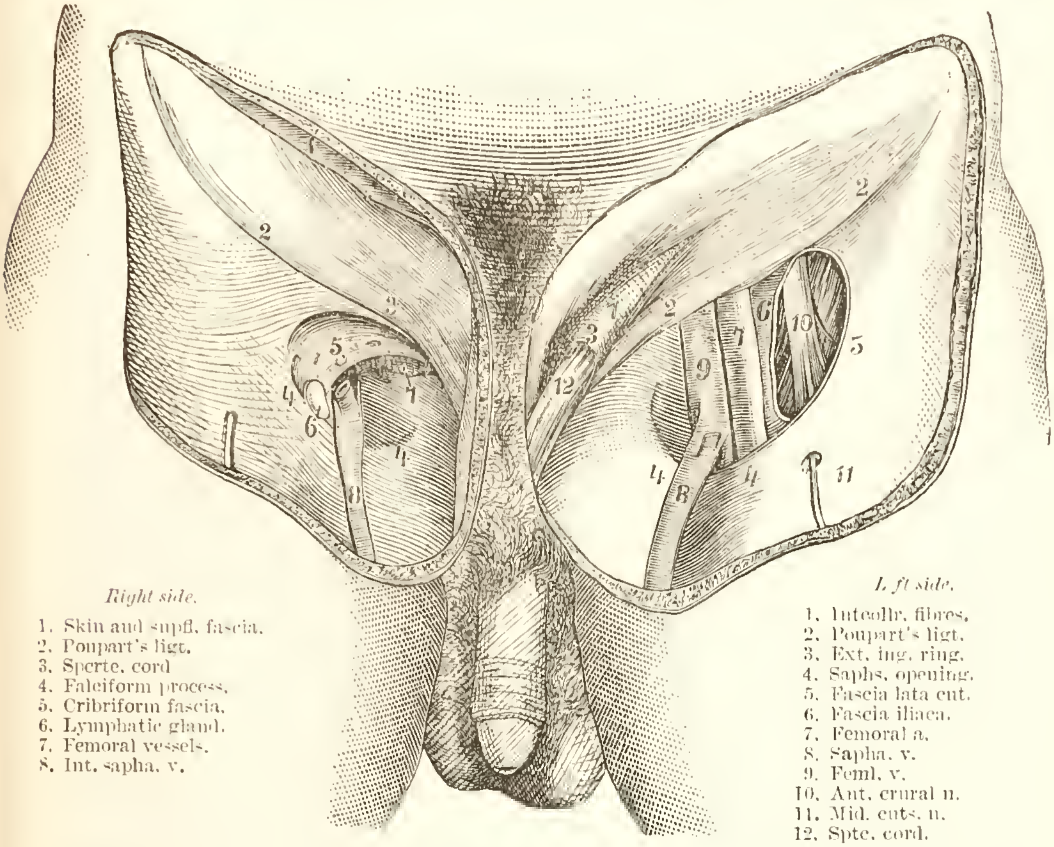


FIG. 245.—DISSECTION OF THE UPPER AND INNER PART OF BOTH FEMORAL REGIONS.

The deeper dissection is on the right of the page.

and reflect the flap inwards. The anterior layer of the femoral sheath will now be exposed and should be cleaned. Then separate the femoral sheath

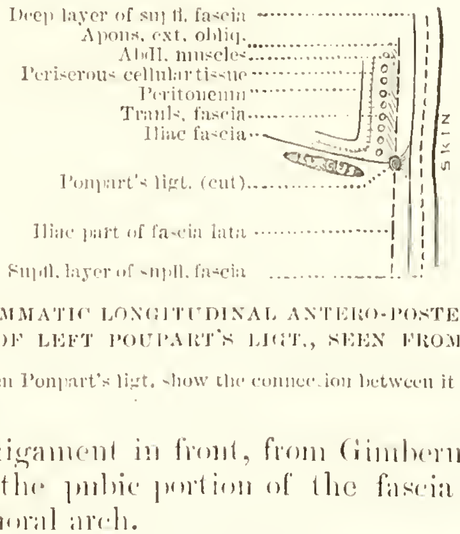


FIG. 246.—DIAGRAMMATIC LONGITUDINAL ANTERO-POSTERIOR SECTION THROUGH OUTER PART OF LEFT POUPART'S LIGT., SEEN FROM THE RIGHT SIDE.

The radiating lines from Poupart's ligt. show the connection between it and the deep layer of superficial fascia.

from Poupart's ligament in front, from Gimbernat's ligament on the inner side, and from the pubic portion of the fascia lata behind. Let us first consider the femoral arch.

Fallopius's or **Poupart's Ligament,** *or the Femoral or Crural Arch, or the*

Ilio-pubic Band or Ligament, is the strong lower border of the aponeurosis of the external oblique muscle of the abdominal wall, and extends from the anterior superior iliac spine to the spine and crest of pubes and ilio-pectineal line. When the fascia lata is uncut, it is arched downwards. Its outer half is oblique, and the inner half is horizontal and widens at the pubes. The structures passing from the pelvis into the thigh nearly fill the space between this ligament and the innominata bone. The *outer* half is occupied by the external cutaneous nerve, the iliacus, the anterior crural, and the psoas; the *inner* half by the femoral vessels in their sheath, and by a small triangular space inside the sheath on the inner side of the femoral vein. This space contains some fatty cellular tissue and sometimes a small lymphatic gland, and is the *femoral canal* along which a

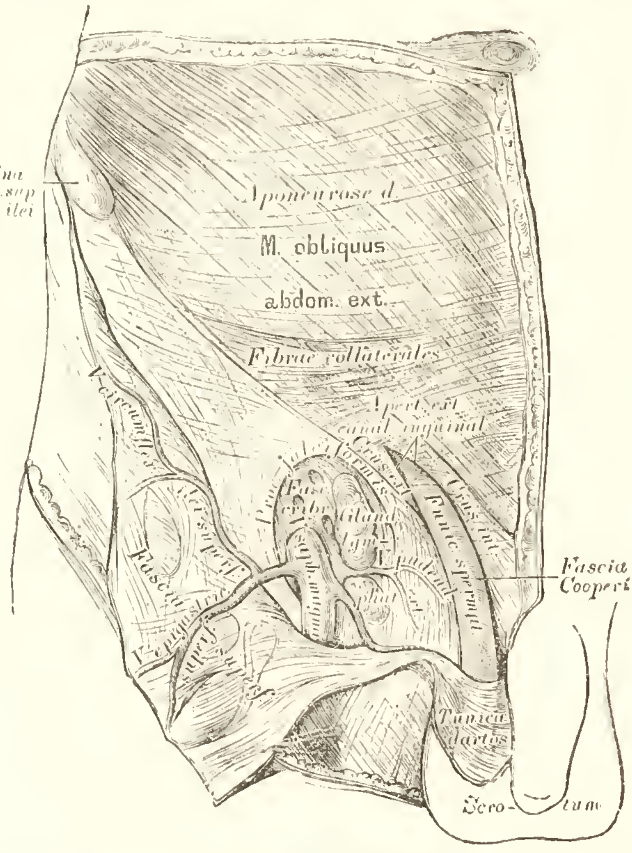


FIG. 217.—DEEPER DISSECTION OF THE RIGHT INGUINO-FEMORAL REGION.

The deep layer of the sup. fl. fascia reflected. The extl. oblique and its aponeurosis are shown.

hernia descends. The student will note that the aponeurosis of the external oblique at its lower part forms Poupart's ligament and the ligament of Colles which is continuous with Cooper's ligament, also Gimbernat's ligament, which will now be described.

Dissection.—To study the femoral sheath and canal, and Gimbernat's ligament, the student must arrange with the dissector of the abdomen, who by this time will have got out inguinal hernia, &c. The peritoneum must be pushed away, after dividing the cord or round ligament, from the external iliac vessels to observe the *septum femorale* and the relations of the vessels, to the internal ring. Poupart's ligament should then be divided carefully an inch outside the sheath, and on reflecting it, the *femoral*

sheath and the deep femoral arch will be exposed. Cut across the sheath about half an inch below Poupart's ligament, and hold up the upper part and observe the septa. Then pass the little finger up into the femoral canal and study its boundaries and relations, and note that the cellular sheath proper to the vessels is distinct from the femoral sheath. The peri-peritoneal cellullo-fatty tissue extends over and across the upper opening of the femoral sheath and canal, and therefore covers the internal femoral ring. The genito-crural nerve will be seen on the external iliac artery.

Gimbernat's Ligament is a part of the insertion of the aponeurosis of the external oblique muscle. It is three quarters of an inch long, and

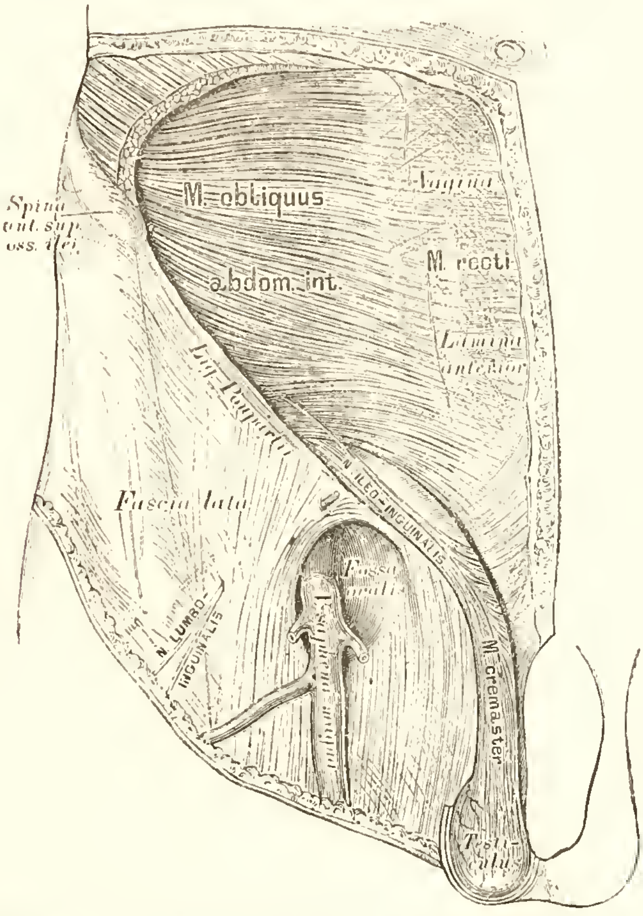


FIG. 248.—DISSECTION OF THE RIGHT FEMORAL REGION, TO SHOW THE FORMATION OF THE SAPHENOUS OPENING.

The intl. oblique and sheath of rectus are shown.

triangular, with its base, which is concave, thin and sharp, directed outwards, and is continuous with the pubic and iliac parts of the fascia lata, and with Cooper's ligament. Its apex is at the pubic spine, its anterior margin is attached to Poupart's ligament, and its posterior to the ileo-pectineal line. In the erect position it is nearly horizontal, and it is larger in the male.

The **Femoral Sheath** is a funnel-shaped, loose membranous tube around the artery and vein. The expanded end of the funnel is above, and the narrow end becomes continuous an inch below Poupart's ligament, with the cellular sheath proper to the vessels. Its *anterior* layer is formed by

the *transversalis* fascia, which is prolonged beneath Poupart's ligament and the deep femoral arch, and the *posterior* layer is formed by and is continuous with the *iliac* fascia. These two layers are continuous on the outer

FIG. 249.—DISSECTION OF THE RIGHT FEMORAL SHEATH AND DEEP FEMORAL ARCH.

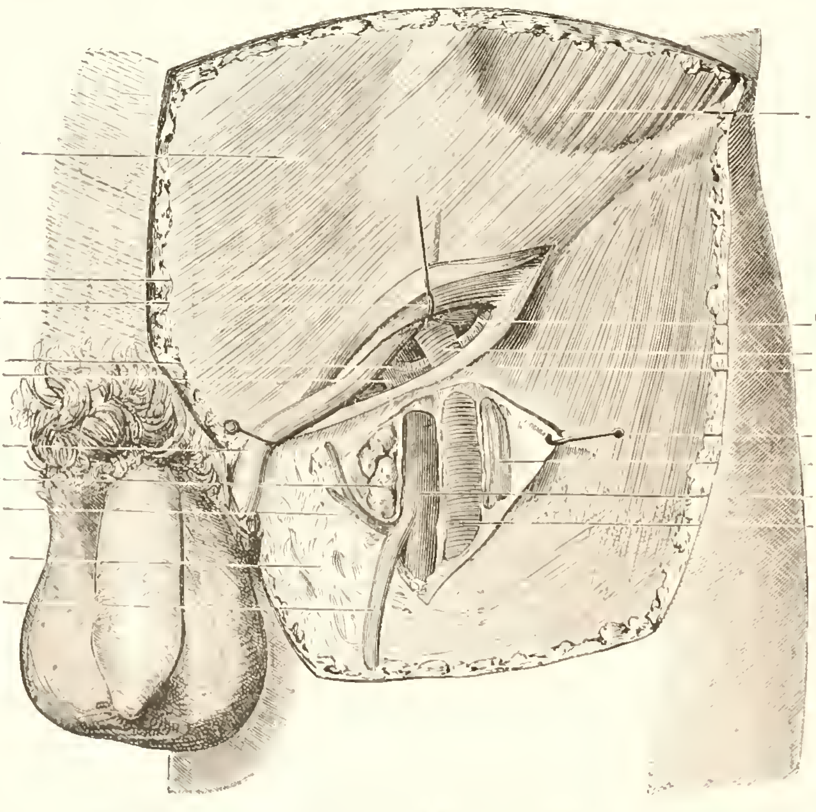


FIG. 250. DEEP DISSECTION TO SHOW THE RELATIONS OF THE LEFT INGUINAL AND FEMORAL CANALS.

The anterior walls of both and the posterior of the former have been cut and raised. The three abdominal muscles are pulled upwards.

side of the artery, but before meeting on the inner side of the vein, a small triangular interval is left which forms the *femoral canal*. There is a thin septum or partition between the artery and vein, and one between the vein and canal. The canal is internal, the artery external, and the vein in the middle. The falciform process and the cribriform fascia are connected with the inner part of the sheath in front, and the pubic portion and Cooper's ligament behind. Its outer border, which is straight, is pierced by the crural branch of the genito-crural nerve, and its oblique border by the saphena vein and superficial vessels and lymphatics. The *deep femoral arch*, when present, crosses the front of the sheath at its upper part.

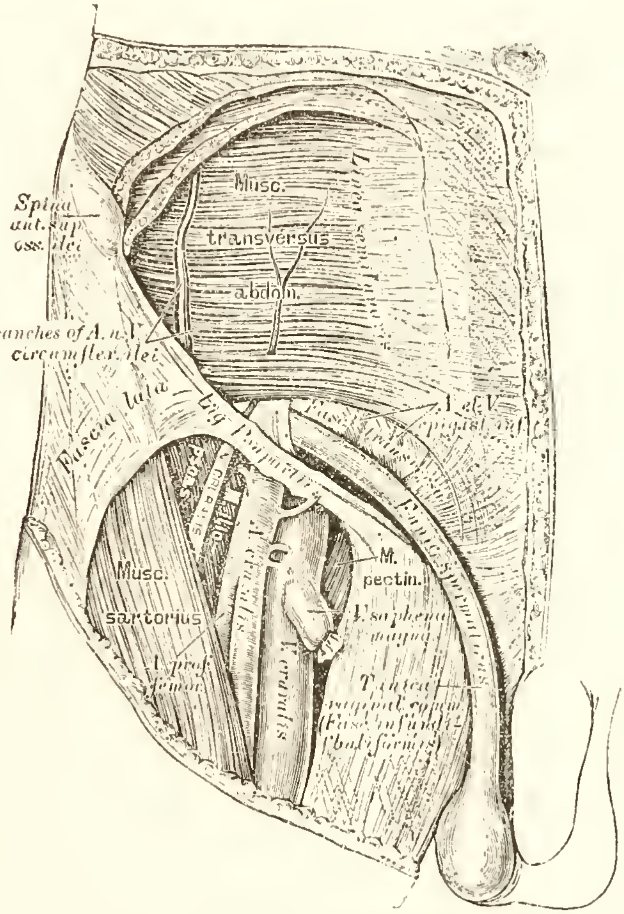


FIG. 251.—DEEP DISSECTION OF THE RIGHT INGUINO-FEMORAL REGION.

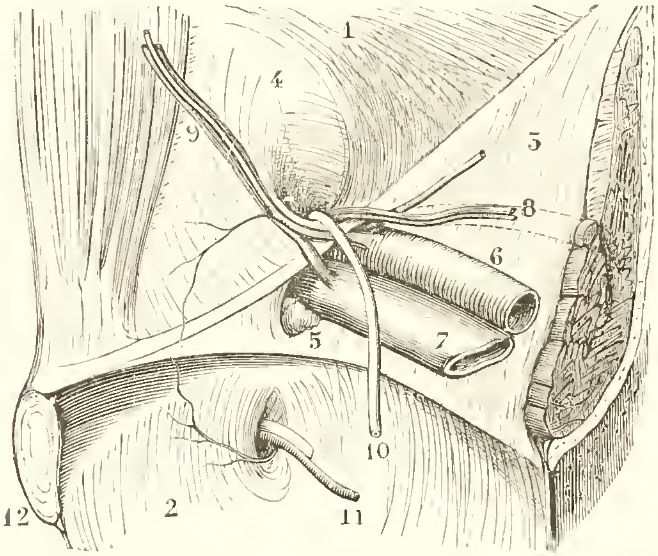
The relative positions of the vessels and nerves above and below Poupart's ligt. are depicted, also the transversalis abdominis.

Some cutaneous filaments from the anterior crural nerve have already been described as piercing the sheath in front and behind.

The Femoral Canal is the triangular interval inside the sheath to the inner side of the vein. It is consequently bounded in front by the fascia transversalis, and behind by the fascia iliaca. It is about half an inch long and extends from the base of Gimbernat's ligament to the upper part of the saphenous opening. It is larger above than below, where it is closed. It contains cellular tissue, some lymphatic vessels, and sometimes a gland. In *front* of it are Poupart's ligament, the deep femoral arch, and the upper part of the falciform process; *behind it* is the pectineus, covered by the

pubic portion of the fascia lata and Cooper's ligament; *inside*, the iliac and transversalis fasciæ meet, and *outside* is the femoral vein.

The **Deep or Internal Femoral Ring** is oval, and about half an inch in its greatest diameter which is transverse, and is larger in the female. This is one reason why femoral hernia is more common in females. It is the upper opening of the canal, and leads into the abdomen. *In front* of the ring are Poupart's ligament and the deep arch; *behind* it are the ilio-pectineal line and the pectineus, covered by the pubic part of the fascia lata and Cooper's ligament; *inside* are Gimbernat's ligament, the conjoined tendon of the internal oblique and transversalis muscles, the transversalis fascia and the deep arch, and *outside* is the femoral vein, separated from it by the septum between it and the canal. The student must note that this ring is immediately *outside and around* the upper or abdominal end of the canal, and is not formed by the fasciæ forming the walls of the latter although these pass from the abdomen to the thigh within it.



1. Fascia tran.
2. Obt. int. covered by fascia.
3. Deep cirf. iliac art.
4. Int. abd. ring.
5. Lymph. gland in femoral ring, Poupart's lig. above it and Gimbernat's ligt. to its inner side.
6. Ext. iliac art.
7. „ vein.
8. Spermatic vessels and cord.
9. Deep epigastric and anastomosis with obt.
10. Vas deferens.
11. Obt. art. and nerve.
12. Symphysis.

FIG. 252.—THE RELATIONS OF THE RIGHT INTERNAL FEMORAL AND ABDOMINAL RINGS SEEN FROM THE INSIDE.

The iliacus, covered by the iliac fascia, is to the right of the figure and is cut, as also is the os innominatum. The rectus is shown just above the symphysis.

The *external* femoral ring, or *saphenous opening*, is *anterior or superficial* to the sheath, so that a hernia would have to carry before it, or tear through the anterior layer of the sheath, before it could pass through this opening.

Relations of the Internal Femoral Ring or aperture.—The structures surrounding the ring outside the femoral sheath have already been mentioned, but I will repeat them. Bounding the canal, and *at its front*, are Poupart's ligament, and the deep crural arch, *inside* are Gimbernat's ligament and the conjoined tendon; *outside* is the femoral vein separated by a fibrous septum; and *behind* are the pubes covered by the pectineus, and the pubic portion of the fascia lata with its thickening, which has been described as a ligament called the *Ligament of Cooper*.

Directions.—To see the vessels and other structures bounding this ring, the student should arrange with the dissector of the abdomen, and

by following the instructions given in the next paragraph he will be able to ascertain, and more readily to comprehend the anatomy, course, relations, and coverings of a femoral hernia.

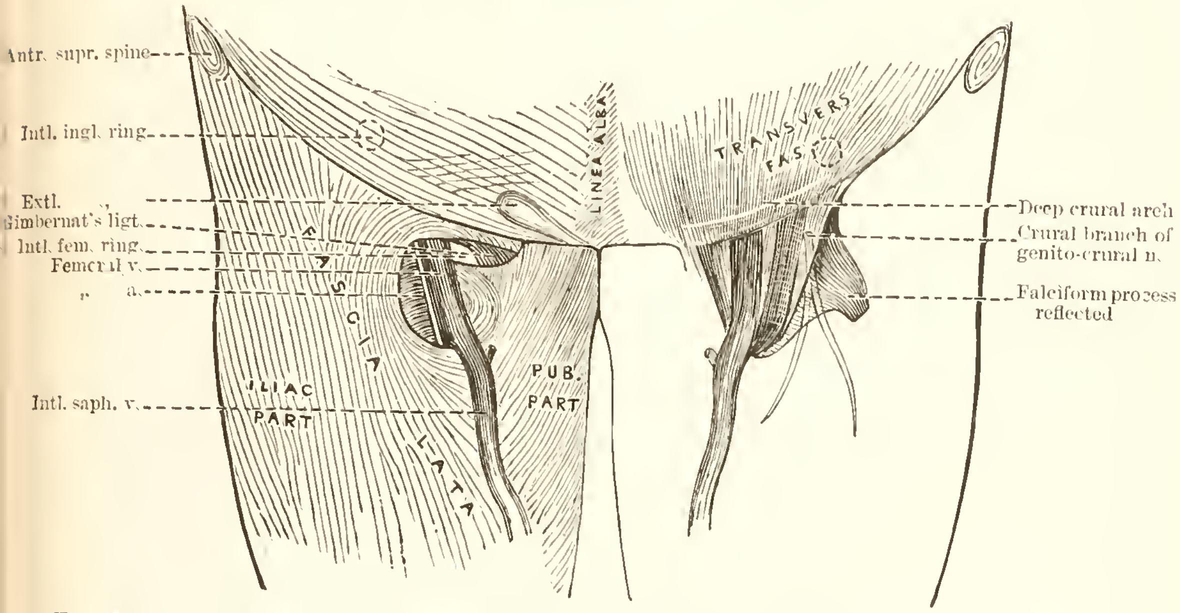


FIG. 253.—DIAGRAM OF THE FEMORAL SHEATH AND OF THE FASCIA LATA FORMING THE SAPHENOUS OPENING.

The sheath is supposed to be transparent to show the positions of the artery and vein.

Dissection.—It is presumed that the abdominal wall and inguinal hernia have been dissected and reflected. On the same side on which the

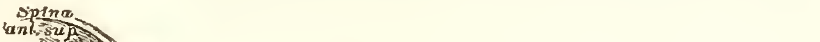


FIG. 254.—VERTICAL TRANSVERSE SECTION THROUGH RIGHT THIGH ON THE SAME PLANE AS POUPART'S LIGAMENT.

femoral canal has been dissected the peritoneum is to be separated from the inner surface of the abdominal wall, and from the iliac fossa, by transverse incisions about two inches above Poupart's ligament.

The spermatic cord must be divided just before it enters the internal abdominal ring, and the sub-peritoneal cellulo-fatty tissue is to be carefully separated from the iliac fossa and abdominal wall by similar transverse incisions. The abdominal aspect of the inner femoral ring and femoral sheath are to be cleaned, and the fascia transversalis in front, and fascia iliaca behind, should be traced to and beneath Poupart's ligament, so as to make out the formation of the femoral sheath. That part of the sub- or supra-peritoneal cellulo-fatty tissue which covers the internal femoral ring should be left; it is the septum femorale, and a lymphatic gland is commonly found on it. In this dissection some lymphatic glands on the

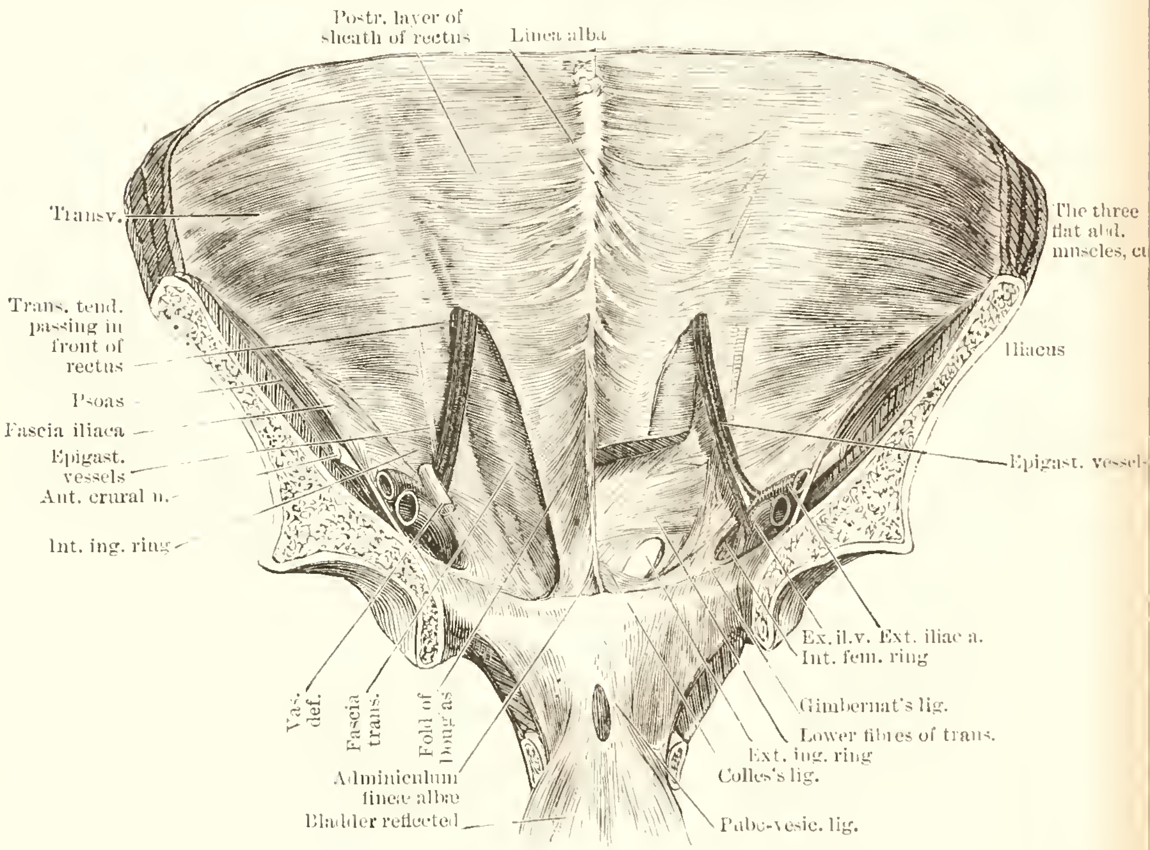


FIG. 255.—INGUINAL AND FEMORAL CANALS SEEN FROM THEIR ABDOMINAL ASPECTS.

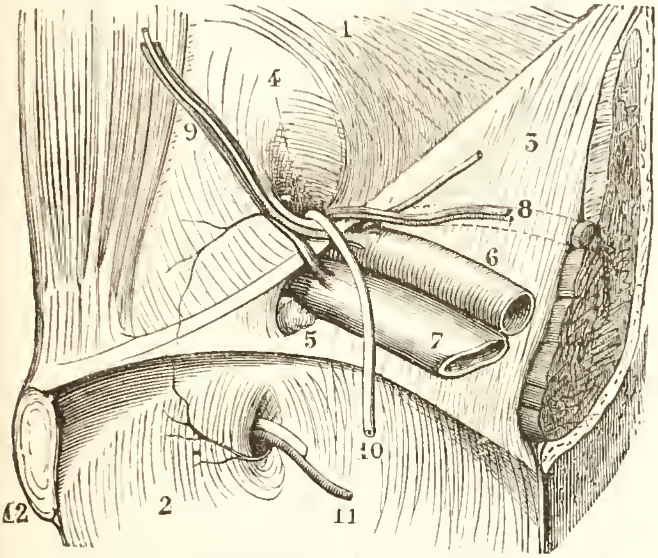
The ilia and rami of pubes cut and lower part of the right rectus removed. The posterior surfaces of the inner and outer pillars are shown on each side of the external ring. The anterior layer of the rectal sheath is shown just below the divided rectus on the right of the figure, and the lines just external to the epigastric vessels indicate the separation of the two layers.

sides of the iliac vessels will be exposed, and the crural branch of the genito-crural nerve will be seen on the iliac artery.

Deeper Relations of the Internal Femoral Ring.—In *front and above* are the spermatic cord in the male (formed by the vas deferens, spermatic artery, spermatic veins, nerves, lymphatics, and the cremaster muscle), and the round ligament in the female. The femoral vein is on the *outer side*, and the epigastric artery is at the *upper and outer* angle of the ring. The pubic or communicating branch between the obturator and epigastric lies in *front* of and *internal* to the ring.

The student will observe that the circumference of the ring is bounded

everywhere, except behind, by vessels; but as the pubic branch is very small and is some distance from the inner margin of the ring, it may be considered that in the male the internal ring is bounded by vessels in



1. Fascia tran.
2. Obt. int. covered by fascia.
3. Deep cirf. iliac art.
4. Int. abd. ring.
5. Lymph. gland in femoral ring, Poupart's lig. above it and Gimbernat's ligt. to its inner side.
6. Ext. iliac art.
7. „ vein.
8. Spermatic vessels and cord.
9. Deep epigastric and anastomosis with obt.
10. Vas deferens.
11. Obt. art. and nerve.
12. Symphysis.

FIG. 256.—THE RELATIONS OF THE RIGHT INTERNAL FEMORAL AND ABDOMINAL RINGS SEEN FROM THE INSIDE.

The iliacus, covered by the iliac fascia, is to the right of the figure and is cut, as also is the os innominatum. The rectus is shown just above the sympysis.

front, above, and on the outer side, therefore the deeper incisions in operating for the relief of a strangulated femoral hernia, should the stric-

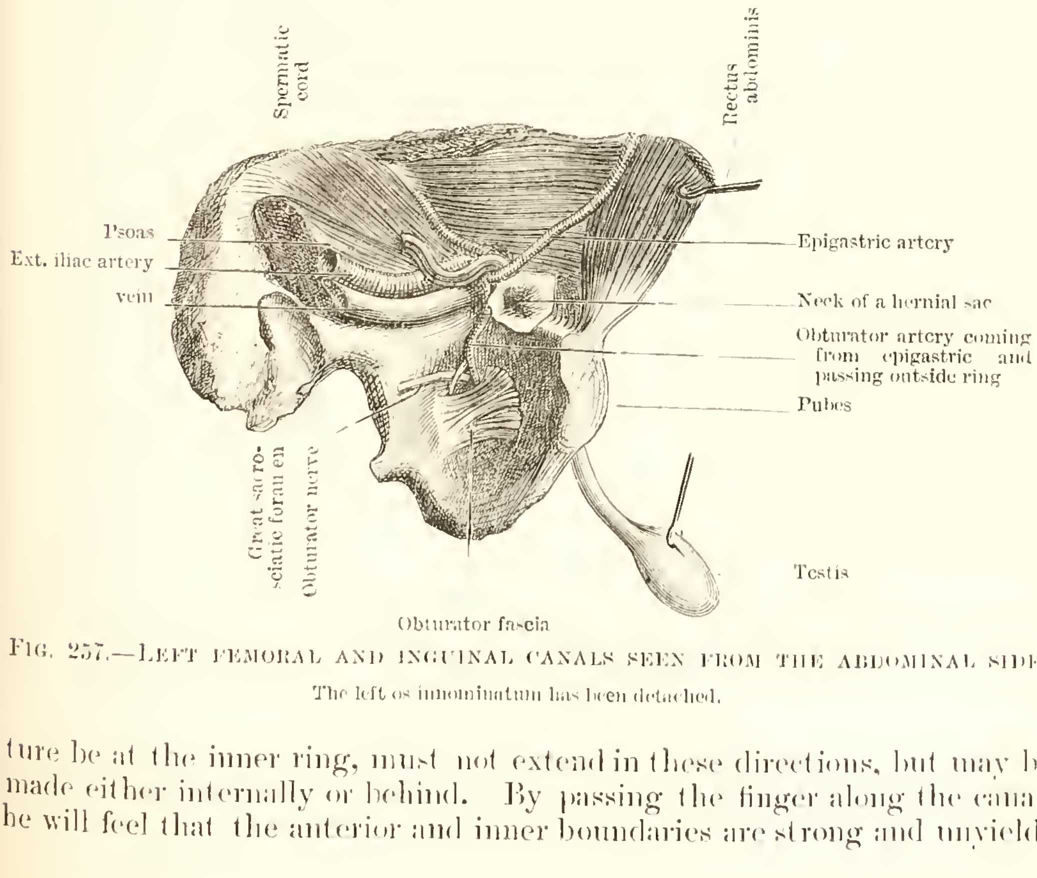


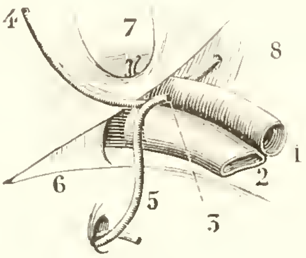
FIG. 257.—LEFT FEMORAL AND INGUINAL CANALS SEEN FROM THE ABDOMINAL SIDE.

The left os innominatum has been detached.

ture be at the inner ring, must not extend in these directions, but may be made either internally or behind. By passing the finger along the canal, he will feel that the anterior and inner boundaries are strong and unyield-

ing, and that their state varies with the position of the limb, for if the thigh be flexed, adducted, and rotated in, these boundaries, i.e. the superficial and deep femoral arches, and Gimbernat's ligament, and the margins of the saphenous opening will be relaxed.

The **Obturator Artery** is usually a branch of the anterior division of the internal iliac, but arises in the proportion of once in $3\frac{1}{2}$ subjects from the epigastric branch of the external iliac. About once in seventy-two subjects it arises by two roots, one from the epigastric and one from the

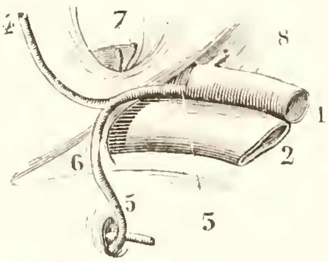


1. Ext. iliac artery.
2. „ vein.
3. Common trunk of epigastric and obturator.
4. Epigastric artery.
5. Obturator artery.
6. Gimbernat's lig.
7. Int. abdom. ring and spte. vessels cut.
8. Cirf. iliac, cut.

FIG. 258.—ABNORMAL OBTURATOR ARTERY. INNER VIEW OF RIGHT SIDE

The common trunk of the epigastric and obturator is short, and the latter descends close to the vein on the *outer* side of the deep ring.

internal iliac, and it is given off in about the same proportion from the external iliac. In the majority of cases these anomalies exist on only one side of the body. In such cases it may have different relations to the internal femoral ring, one of which is of great practical importance. The more common and less important arrangement is for the abnormal obturator to arise from near the root of the epigastric and to lie on the inner side of the iliac vein, and to pass vertically down to the obturator foramen. In this course it is placed on the *outer* side of the ring, and is not in



1. Ext. iliac artery.
2. „ vein.
3. Common trunk of epigastric and obturator.
4. Epigastric artery.
5. Obturator artery.
6. Gimbernat's lig.
7. Int. abdom. ring and spte. vessels cut.
8. Cirf. iliac, cut.

FIG. 259.—ABNORMAL OBTURATOR PASSING ON GIMBERNAT'S LIGAMENT INTERNAL TO THE DEEP RING.

In this case the common trunk of epigtc. and obtr. is long.

danger of being wounded, as incisions are never made in this direction. But about once in seventy-five subjects the artery is given off from the epigastric higher up, and runs along the outer free margin of Gimbernat's ligament, and is in close relation with the *inner* side of the neck of a femoral hernia, and would be in great danger of being wounded if the deep incisions were free. I have seen this abnormal vessel on the inner side of the ring, and yet not in danger of being wounded, if, in dividing Gimbernat's ligament, its edge were carefully nicked instead of being too

freely cut. There was a good one-eighth of an inch between the vessel and the free edge of Gimbernat's ligament. In two cases I have seen the vessel obliquely cross the ring, from without downwards and inwards, but there was space enough *above* it to divide Gimbernat's ligament without risk to the vessel.

The **Septum Femorale,** or **Crurale,** is that portion of the sub-peritoneal cellulo-fatty tissue which is thickest and most fibrous at the lower part of the abdomen, and passes over the upper opening of the femoral sheath; internal to the vein it covers over the internal abdominal ring, and may have a lymphatic gland either on its abdominal or femoral surface. Cloquet named the part of it which covers the internal ring the

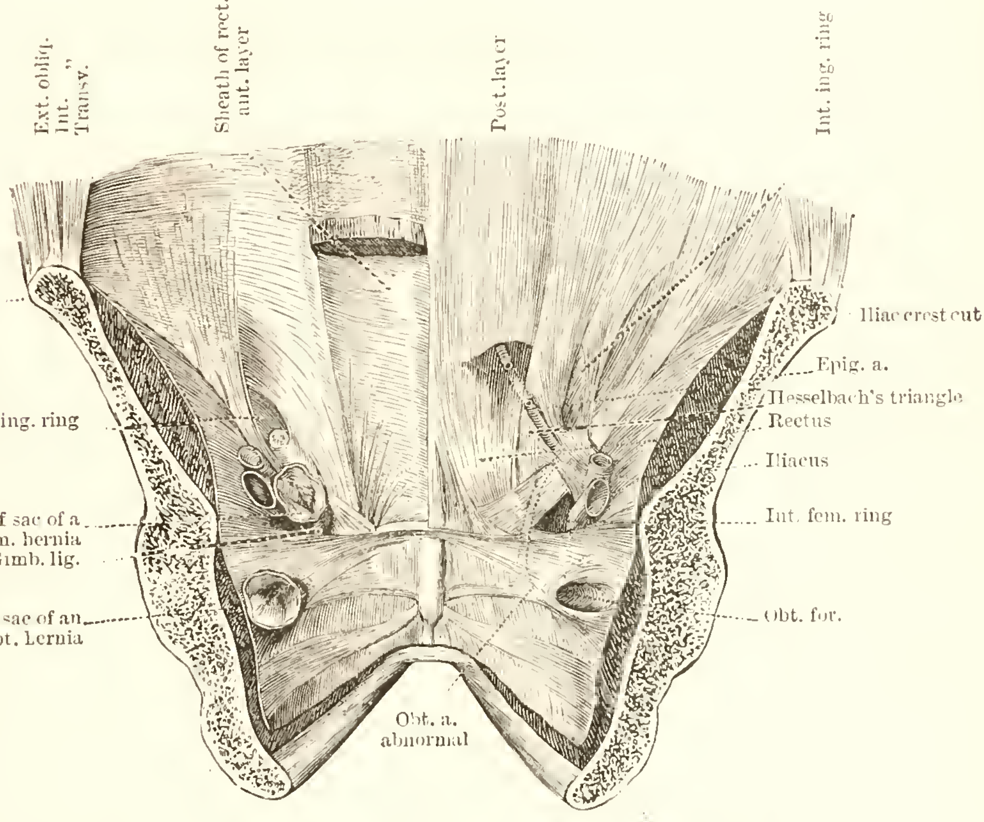


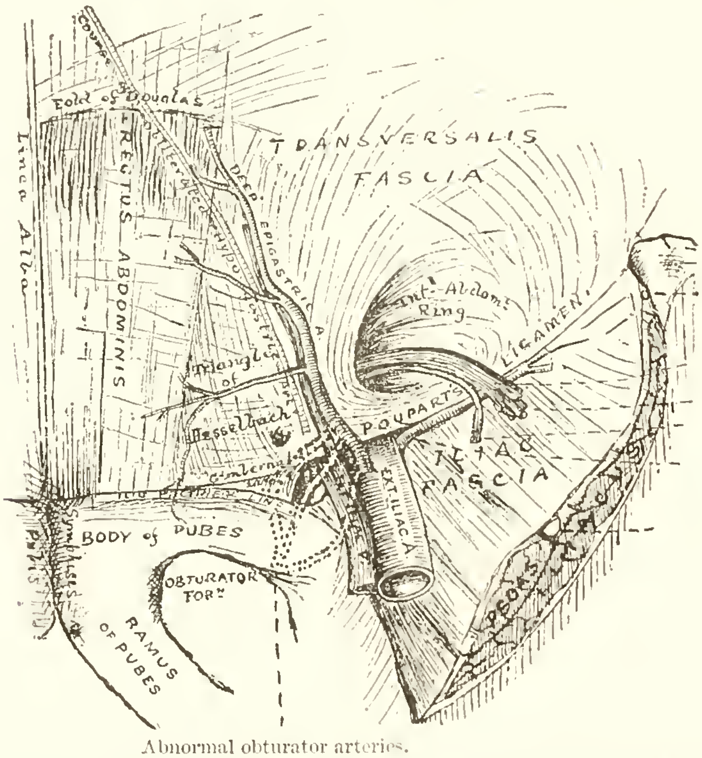
FIG. 260.—INT. ABDOMINAL AND FEMORAL APERTURES SEEN FROM WITHIN.

The ilio-psoas, obturator internus, and levator ani cut. The continuity of the iliac fascia with the obturator and transversalis fascia is shown.

septum crurale from its position between the thigh and abdomen. Its upper surface is slightly concave, and its lower or femoral surface is convex. It is perforated by several lymphatic vessels which connect the deep inguinal glands with those around the external iliac artery. The septum femorale is separated by some loose areolar tissue from the peritoneum, and in some cases it contains much fat which, if protruded in front of the sac of a femoral hernia, may by an inexperienced operator be mistaken for omentum. I have seen this layer much thickened, condensed, and hardened from the pressure of a truss.

The **Natural Course in the Descent of a Femoral Hernia.**—*Instructions.*—If the student will pinch up a piece of small intestine, and after replacing

the peritoneum and supra-peritoneal fatty tissue in the position from which they have been displaced, endeavour to force the intestine through the internal ring on the inner side of the femoral vein until his finger reaches the saphenous opening, he will get a correct idea of the course, covering, relations, and seats of stricture, of the two chief varieties of femoral hernia. There would be considerable difficulty in stretching the peritoneum if it had not previously been dissected free from its attachments. The student must now understand that the formation of a hernia in the living is in the majority of cases a gradual process. A pouch of peritoneum having been gradually distended either through congenital debility of the weak points of the abdomen, or through repeated muscular efforts, such as coughing, straining, or through child-bearing, any extra effort may then force a fresh piece of intestine or omentum into the peri-



Abnormal obturator arteries.

FIG. 261.—THE RIGHT INTERNAL FEMORAL RING, SEEN FROM WITHIN.

The dotted vessels represent three abnormal positions that an unusual obturator artery may take.

toneal pouch, and push the latter downwards along the canal, through the saphenous opening and under the skin. This would form a *complete* femoral hernia; but should from any cause, i.e. insufficiency of the expulsive force, or an adhesion, or obstruction in the femoral canal, the hernia be retained in the canal, it cannot get out through the saphenous opening, and thus an *incomplete* femoral hernia is the result. This form of hernia is usually small because of the resisting nature of the surrounding parts, but the complete form may be large because it is free to expand in the loose areolar tissue beneath the skin.

Course.—The direction of a femoral hernia is at first downwards, through the internal ring, and into the canal, and if it be a complete hernia it will change its direction at the saphenous opening and pass forwards and

upwards, and may elongate transversely over Poupart's ligament. It does not usually pass downwards, either in the canal or when it has become subcutaneous, because in the former situation the femoral sheath is closely adherent to the proper sheath of the femoral vessels near the lower part of the saphenous opening; and in the latter position the connection of the layers of the superficial fascia between themselves is firmer than towards the groin, where they are separated by the lymphatic glands and superficial vessels, and also because of the firm attachment of the cribriform fascia and anterior layer of the femoral sheath to the lower part of the margin of the saphenous opening.

Coverings.—The intestine or omentum carries before it a pouch of the peritoneum which is called the *sac* of the *hernia*; the sub-serous cellular tissue, the septum femorale, the cribriform fascia which covers the saphenous opening, the superficial fascia and fat, and the skin, these are the

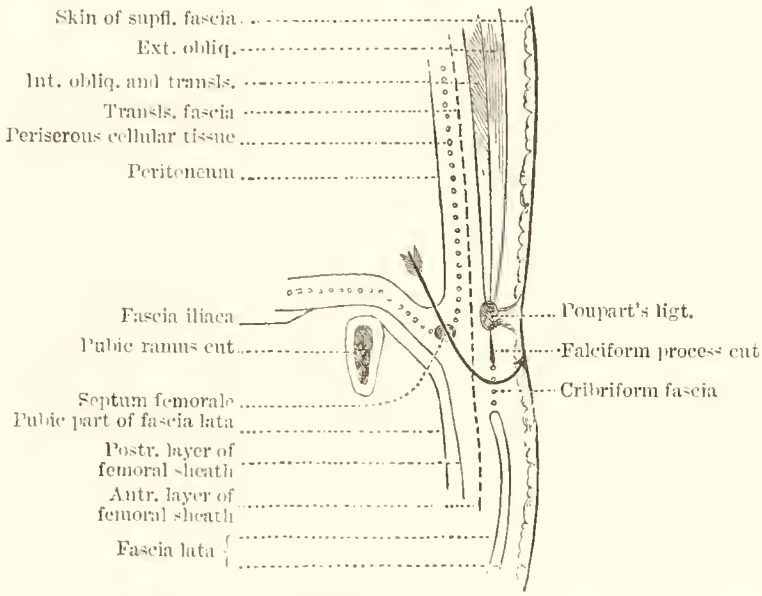


FIG. 262.—DIAGRAM OF A LONGITUDINAL ANTERO-POSTERIOR SECTION THROUGH THE LEFT FEMORAL CANAL, SEEN FROM THE RIGHT SIDE.

The arrow shows the course of a complete femoral hernia. The connection between the deep layer of supfl. fascia and Poupart's ligt. is represented.

coverings of the *complete form* of femoral hernia. The difference between the coverings of this and the *incomplete form* is explained by the fact that the latter does not leave the canal, and consequently, has in front of it, instead of the cribriform fascia, the anterior layer of the femoral canal which is formed by the fascia transversalis.

Coverings of Femoral Hernia.

Complete form.

Peritoneum.
Subserous cellulo-fatty tissue.
Septum femorale.
Cribriform fascia.
Superficial fascia.
Skin.

In the *incomplete form*, substitute fascia transversalis for cribriform fascia.

Pathological conditions, or individual variations, may produce certain changes in the normal coverings of a hernia; thus the anterior layer of the canal may form one of its coverings, or it may break through the anterior layer and be constricted by it. In old herniæ the septum femorale may be united with the anterior layer of the canal forming the *fascia propria* of Sir Astley Cooper. This may be immediately external to the sac, but is often separated from it by adipose tissue. It is important to remember that this condition may be occasionally present so as to prevent mistaking the fascia for the hernial sac, and the fat within it for omentum. Sometimes this fascia is formed by the subperitoneal cellular tissue which by the pressure of the truss is rendered thick and membranous.

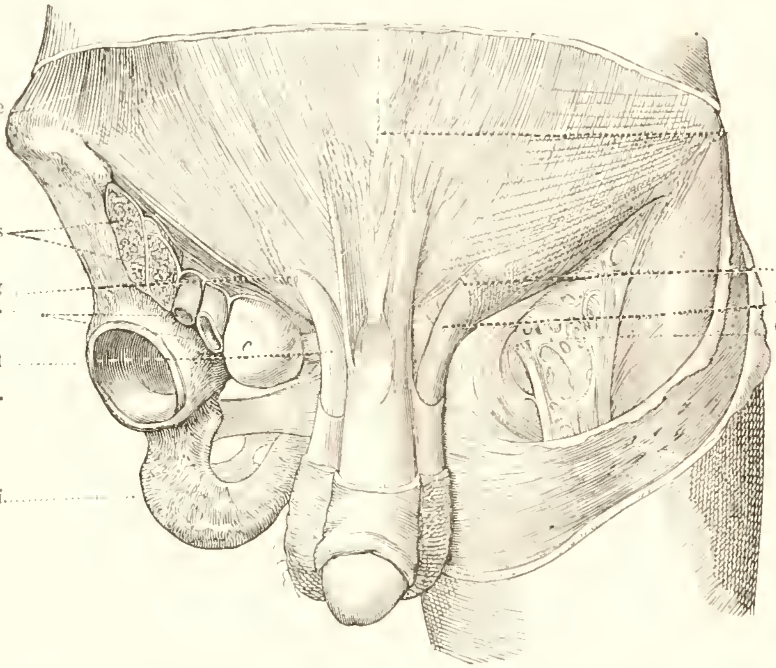


FIG. 263.—DISSECTION TO SHOW THE RELATION OF A SMALL FEMORAL HERNIA *c* TO THE FEMORAL VESSELS.

The anterior crural nerve is seen between the psoas and iliacus, and the obturator foramen and fascia, uncovered by muscles, are below the hernia.

In operating, the surgeon does not heed, or expect to meet with, the different layers as found in dissection, but cuts down at once, carefully, upon the narrow part or neck of the sac where it is constricted, and finds the peritoneum, which is usually recognised by its bluish white, glistening aspect if it be not diseased. The constricting bands are divided *outside* the sac, and the bowel is endeavoured to be returned. Should this not succeed, the sac must be opened, any stricture within must be divided, and the bowel or omentum returned or not, according to its condition.

Varieties of Femoral Hernia.—These have been mentioned in passing, but it would be well to say a few more words concerning them. A *complete femoral hernia* enters the femoral canal through the internal femoral ring, passes along the canal, leaves it through the *upper* part of the saphenous opening, and gets under or between the layers of the superficial fascia and beneath the skin, having *behind* it the falciform process of the fascia lata and the lower portion of the tendon of the external oblique

muscle. An *incomplete femoral hernia* descends some distance along the canal, usually as far as the saphenous opening, but does not escape through this aperture. This form of hernia is small, on account of the firm and resisting character of the tissues bounding the canal, and is dangerous because of the difficulty of feeling or seeing it, and because it takes a shorter period of strangulation to damage the intestine in this kind of rupture on account of the dense nature of its surroundings. In fat people it is often difficult to diagnose it; but the surgeon will not delay an exploratory operation if there be vomiting with pain in this region or in the abdomen, provided no other satisfactory cause be found to explain the symptoms.

In rare cases the hernial sac protrudes on the outer side of the femoral vessels, in front of, or even behind, and sometimes between them. The diagnosis of these different forms and of the other affections which may be mistaken for a femoral hernia the dissector will study in his works on surgery in a more advanced stage of his curriculum; but by making himself once and for all familiar with the salient features of the anatomy of femoral and inguinal hernia he will be prepared, subsequently, to deal with any emergency. It may, however, be here stated that a femoral hernia is usually to be recognised from an inguinal by its smaller size, and by the fact that it does not pass into the scrotum or labium, although in a recent case of strangulated complete femoral hernia on which I operated, it bulged beyond the groove separating the thigh from the labium majus. In such a case it will be observed that the rupture cannot be followed up into the inguinal canal, and that its neck can be traced *below* Poupart's ligament, although its expanded base may lie above that structure; in other words, a femoral hernia, whether complete or incomplete, has its *neck* below Poupart's ligament, and does not pass into the labium, or along the cord into the scrotum; whereas an inguinal hernia, whether complete or incomplete, is always in the inguinal canal which is above Poupart's ligament; and in the latter form it protrudes into the scrotum or labium.[1]

Seats of Stricture.—These may be external or internal to the neck of the sac, or in its substance; and the external constricting bands are usually formed by the fascia or tendinous structures bounding the rings. The external cause of stricture may be situated at the inner or outer ring, or in the canal, but its most common seat is at the *internal* ring, where it is usually formed opposite the base of Gimbernat's ligament, where the falciform process of the fascia lata joins it. The falciform margin of the saphenous opening may also constrict the hernia, and after cutting down on the inner side of the neck of the sac any constricting bands at the saphenous opening, or deeper in at the internal femoral ring, should be carefully divided to the extent of two or three lines in a direction directly inwards, or inwards and upwards. The constriction, if at the external ring, may be more freely divided if necessary. If the hernia cannot be replaced after having divided these structures, and if the finger can be passed towards the abdomen by the side of but external to the hernial sac, the operator would conclude that the obstruction to the return of the intestine lay either within the sac or in its substance.

[1] Even the rare interstitial forms of inguinal herniæ come through some portion of the canal.

If the stricture be in the substance of the sac it is caused by a thickening at its neck. This will have to be cautiously scratched through and the taxis again applied. Should this proceeding not succeed, the sac must be carefully pinched up over a piece of omentum, or over some fluid which it generally contains, so as to avoid wounding the gut. An opening must be made into it sufficiently large to introduce the finger, which should be

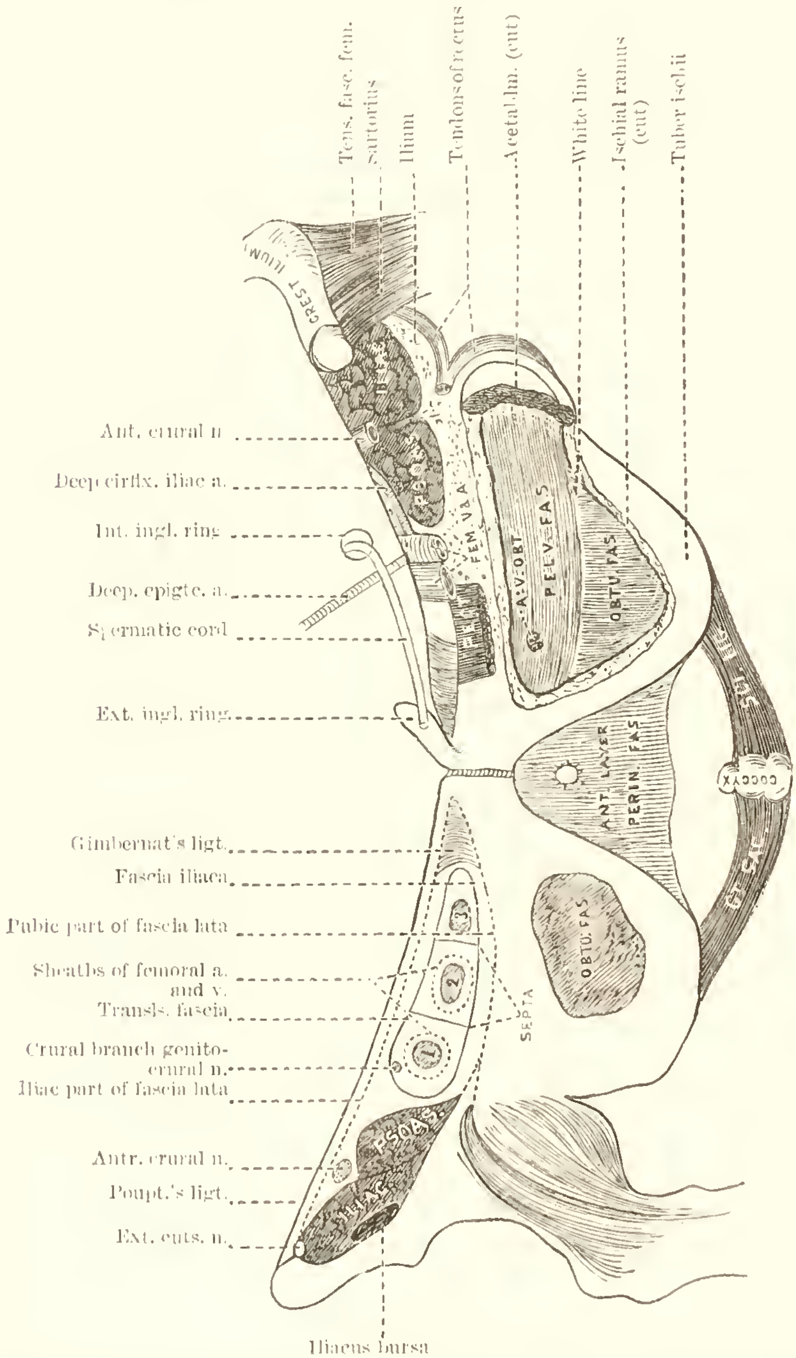


FIG. 264.—DIAGRAM OF THE FEMORAL SHEATH AND OF THE FEMORAL ARCH AND STRUCTURES PASSING BENEATH IT. ALSO OF PARTS OF THE PELVIC, OBTURATOR, AND PERINÆAL FASCIÆ.

The bone around the obturator foramen has been chiselled away to show the junction of the pelvic and obturator fasciæ. The great sacro-sciatic ligt. passes from the tuber ischii to the coccyx. 1. Femoral artery. 2. Femoral vein. 3. Femoral ring (internal) within the femoral sheath. On the right of the figure, Gimbernat's ligt. and the int. feml. ring are seen just above the pectineus.

passed with its fleshy part towards the intestine; a probe-pointed bistoury must be introduced carefully along it, and the thickened neck of the sac and some fibres of the edge of Gimbernat's ligament must be divided in an inward direction. The gut and omentum will then most likely be able to be returned, but if not the operator will seek for the third cause of irreducibility.

The strictures inside the sac may be due to various pathological conditions, such as adhesion of the coils of intestine to each other and to the sac, or to the omentum which may be adherent to the sac. These may, if considered desirable, be separated and the protruded parts returned, or, after seeing that the strictures are well divided, and the canal and its apertures quite free, the intestine may be left where it was found, and the wound closed.

Danger to surrounding Parts.—As already stated, the deeper incisions or nicks, in dividing a stricture at the internal ring, must only be

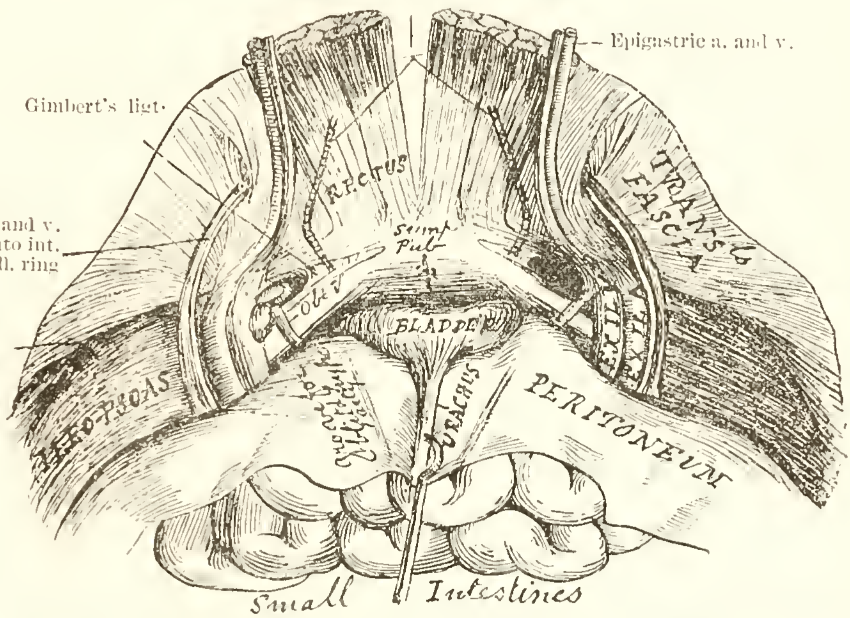


FIG. 265.—DISSECTION OF THE INTERNAL FEMORAL RINGS FROM WITHIN. THE PERITONEUM AND BLADDER REFLECTED.

made in an inward direction, or inwards and upwards, or backwards. Gimbernat's ligament would be divided in the former case, and in the latter the pubic portion of the fascia lata and Cooper's ligament. It must not be made forwards for fear of injuring the vas deferens and the spermatic vessels. In the female it would not matter so much, because the round ligament is not so important or vascular a structure as the spermatic cord, but the forward direction of the incision must be avoided in either sex because the abnormal obturator artery curves along the lower edge of Poupart's ligament to get to the inner side of the ring, and the bistoury must not be directed outwards lest the femoral vein be wounded.

In the usual inward direction of the incision the pubic branch of the epigastric and the spermatic cord will not be injured unless the cut be too extensive. Lawrence states that once in about eighty operations the obturator artery will be found to take the unusual course in front, i.e.

above and on the inner side of the neck of the sac. In the dissecting-room and post mortem table this variety of the obturator is found about once in seventy-five subjects, and as operations for hernia are much less frequent than post mortems or dissections, it is probable that the latter estimate is the more correct, but it must be borne in mind that this abnormal condition may be present in many cases of hernia which have been reduced without a cutting operation, and that even in some of those which have been operated on, it may have been on the inner side of the ring and yet not sufficiently close to the free edge of Gimbernat's ligament to be wounded. In the dissecting and post mortem rooms I have seen at least five instances in which the vessel was on the inner side of the ring, and many in which it was on the outer side. The enquiring student may with a very little trouble ascertain in the course of a year whether the proportion of one in seventy-five be correct by examining both sides of

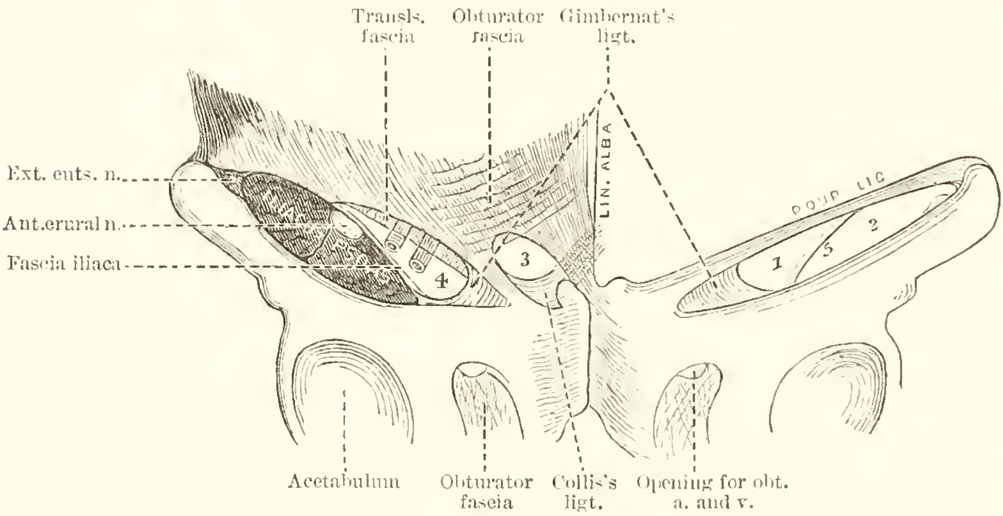


FIG. 266.—DIAGRAM OF THE FEMORAL ARCH, AND TO SHOW THE ANTERIOR AND POSTERIOR LAYERS OF THE FEMORAL SHEATH.

1. Space for femoral vessels. 2. Space for iliacus and psoas. 3. Ext. ingl. ring. 4. Int. femoral ring. 5. Septum of fascia lata. The femoral vessels, with the fascia transversalis passing in front and the fascia iliaca behind, are shown on the left of the figure. The insertions of the ext. oblique to the pubes, to the linea alba by Collis's ligt., and to the ilio pectineal line by Gimbernat's ligt. are depicted.

every subject on the post mortem table; and if he have access to the pathological department of the London Hospital, where the largest number of post mortems are annually made, he will be able in twelve months to accumulate facts which may throw much additional light on this interesting and important subject.

Having again gone through the anatomy of femoral hernia, and feeling by self cross-examination that he thoroughly understands it, the student must proceed with the dissection of Scarpa's triangle.

SCARPA'S TRIANGLE.

Dissection.—Remove the fascia lata from the upper third of the thigh and clean the muscles, vessels, and nerves which are exposed. In removing the fatty tissue from beneath the common femoral artery, be careful of one or two small nerves from the anterior crural to the pectineus

muscle. The femoral sheath is to be removed, and the superficial femoral vessels traced as far as the apex of the triangle.

This hollow space corresponds with the axilla of the upper limb, and is placed at the upper and inner part of the thigh. It is situated beneath the depression seen just below Poupart's ligament, and is triangular in shape, having its base above and its apex below.

Its base is formed by Poupart's ligament, and its apex by the meeting

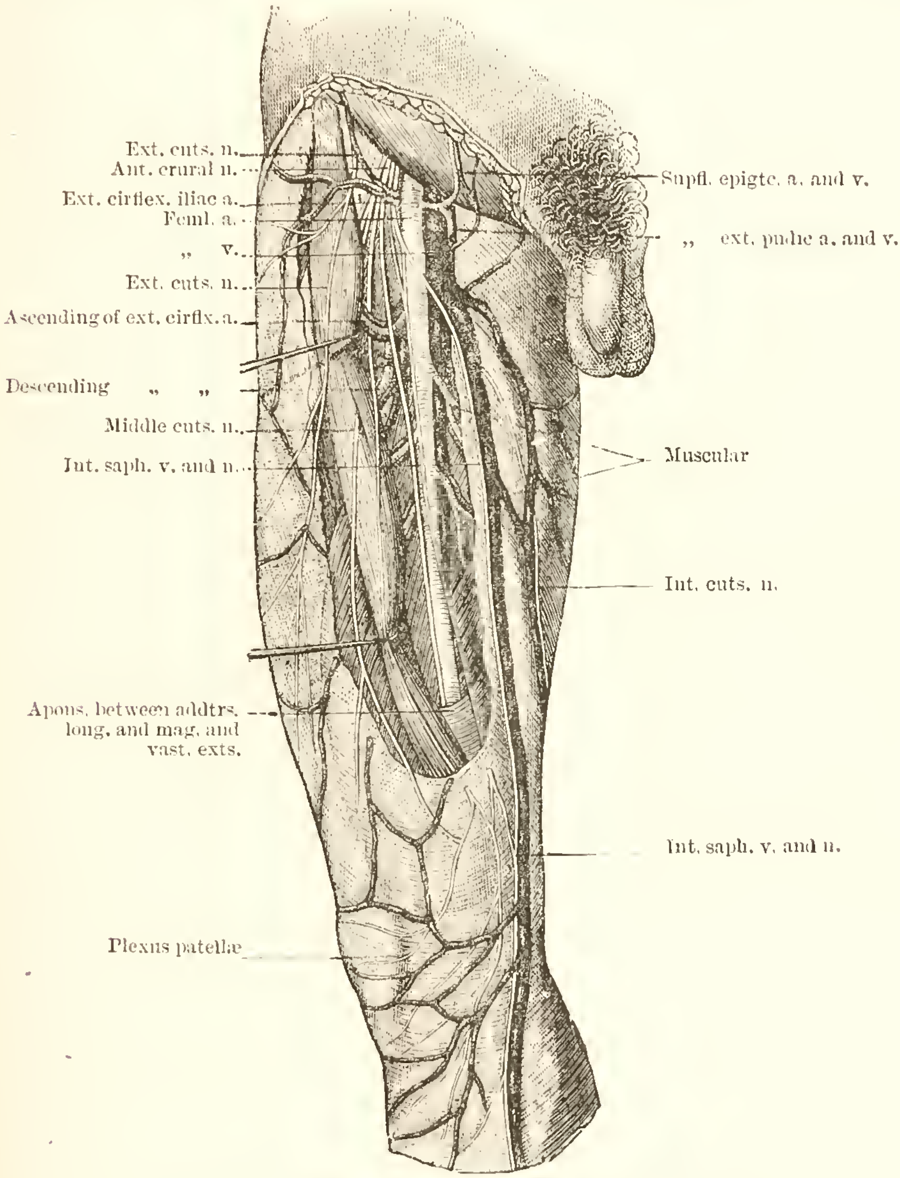


FIG. 267.—DEEPER DISSECTION OF RIGHT THIGH.

The sartorius is hooked back.

of the sartorius and adductor longus. Its outer border is formed by the inner edge of the sartorius, and its inner border by the outer edge of the adductor longus. It is about three inches from above downwards, but its length varies with the breadth of the sartorius and with the height at which it crosses inwards. It is covered in by the skin, superficial fascia, and fascia lata, and its floor, which slopes towards the middle, where it is

deepest, is formed from without inwards by the iliacus, psoas, pectineus, and small portions of the adductors brevis and longus.

Contents.—This triangle is bisected into two nearly equal parts by the femoral artery, which passes through the centre of the hollow from the base to beyond its apex, and gives off its cutaneous and profunda branches. On the inner side of the artery and close to it, between the margins of the pectineus and psoas, is the femoral vein which receives the deep femoral and internal saphenous veins. The large anterior crural nerve is placed about half an inch external to the artery, and is at first deeply seated between the psoas and iliacus, but subsequently is more superficial, and divides into its anterior and posterior branches. The artery and vein are enclosed in a strong fibrous sheath (the femoral sheath), and are still further protected by the fascia lata, and are separated from each other by thin

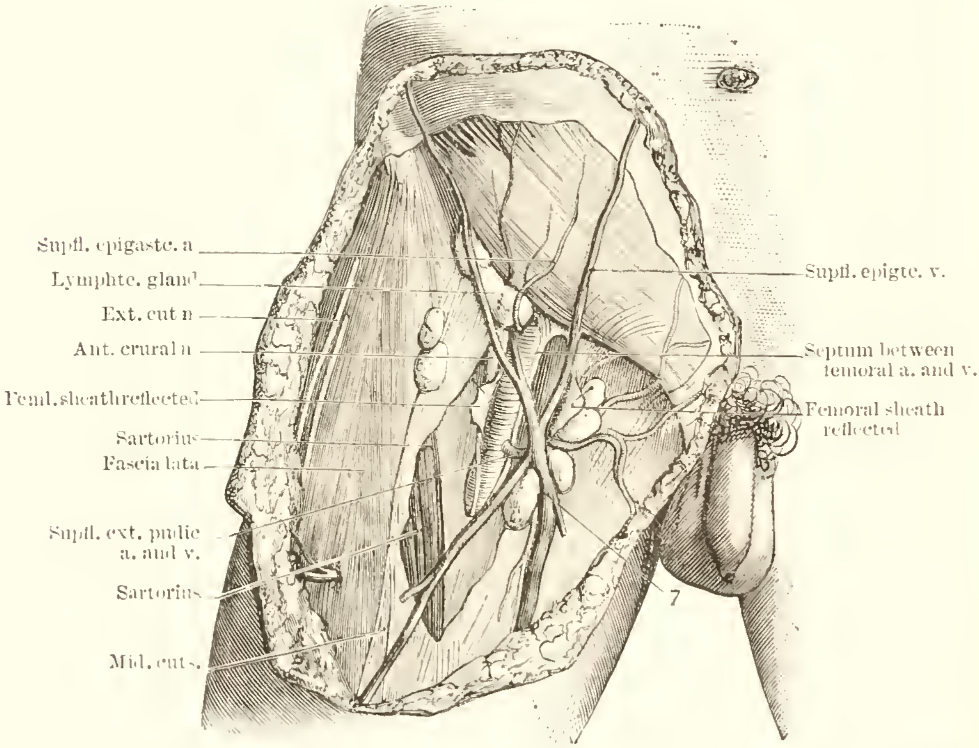


FIG. 268.—DISSECTION TO SHOW THE UPPER PART OF THE FEMORAL ARTERY AND VEIN.

The middle cutaneous of the anterior crural is seen on the artery. 7 is the long saphena vein.

fibrous partitions. Deep lymphatic vessels accompany the femoral vessels. They are joined by the superficial lymphatics and pass into the glands surrounding the external iliac artery.

The **Femoral Artery** is the continuation of the external iliac, and extends from the lower border of Poupart's ligament to the margin of the adductor opening, whence it is continued on into the popliteal space under the name of the *popliteal artery*. A line drawn from a little internal to the middle of Poupart's ligament to the inner side of the inner femoral condyle, will indicate the course of the vessel. It passes down the forepart and inner side of the thigh, and at the upper part of the thigh is slightly internal to the head of the femur, and is comparatively superficial, being uncovered by muscles, but in the lower part of its course it is on the inner

side of the femoral shaft, and is beneath the sartorius, being separated from the bone by a considerable extent, in consequence of the artery running a straight course, and of the projection of the neck and shaft of the femur outwards. It occupies about two-thirds of the thigh, and is superficial in Scarpa's triangle, but deeply placed beyond it.

Relations.—Only the superficial portion of the artery is now being dissected. The deep part will be studied in the next section; but for

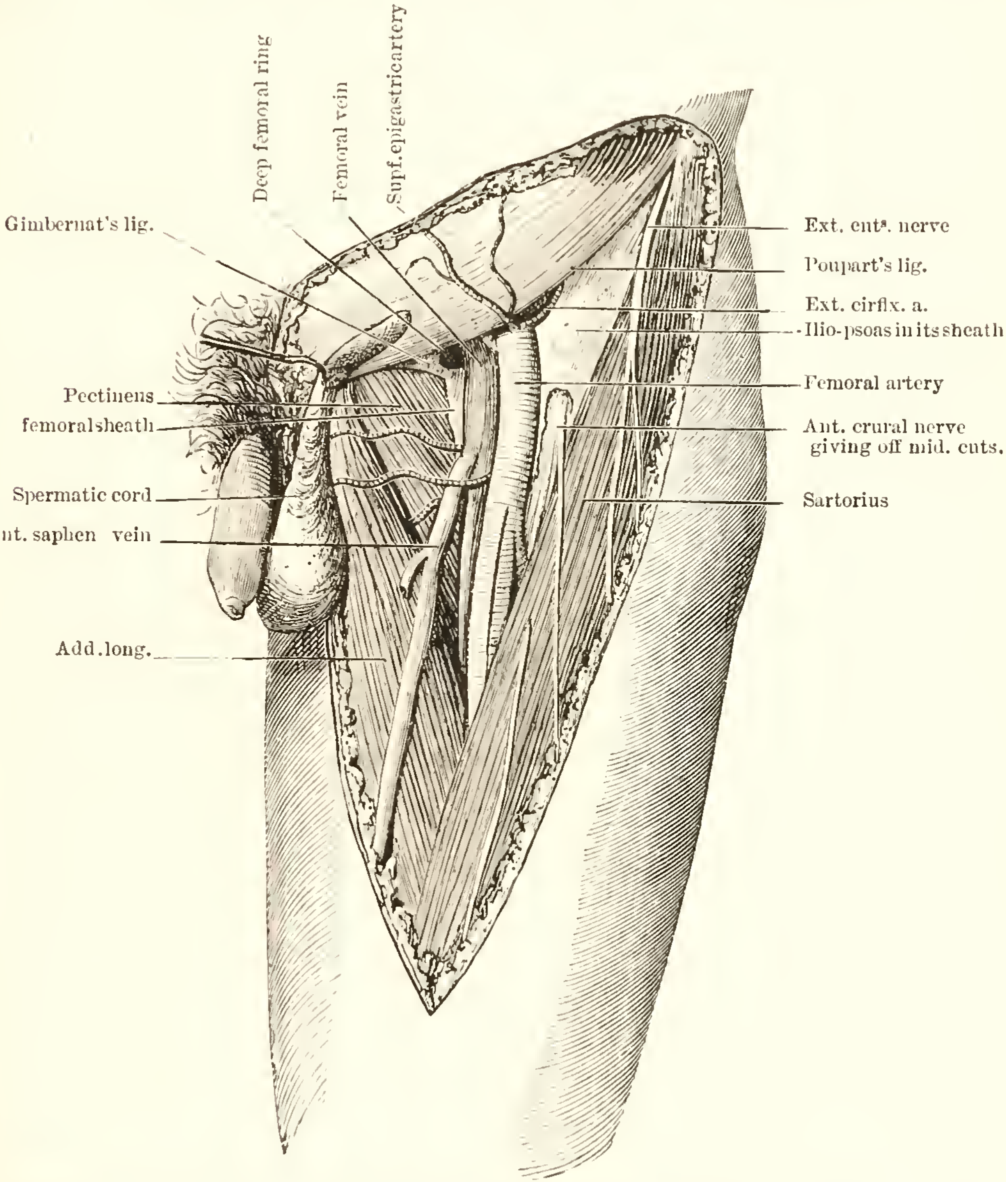


FIG. 269.—LEFT SCARPA'S TRIANGLE, DEEPER VIEW, AND THE DEEP FEMORAL RING.

The external pudic arteries are seen passing under the spermatic cord.

the convenience of the student the relations of the entire vessel will now be given.

In *front* of it, from above downwards, are the skin and superficial fascia, fascia lata, the crural branch of the genito-crural nerve and some branches of the anterior crural, the sartorius, the long saphenous nerve and vein, and the aponeurotic covering of Hunter's canal.

Behind it, from above downwards, are the nerve from the anterior crural to the pectineus, the psoas, which separates it from the pelvic margin and from the hip capsule, the profunda vessels and femoral vein separating it from the pectineus, the adductor longus, and the tendon of the adductor magnus separated from it by the femoral vein.

To its *inner* side are the femoral vein above, and adductor longus and sartorius below.

At its *outer* side and lower part are the vastus internus and femoral vein. The internal saphenous nerve is also on the outer side of the artery in Hunter's canal, but is external to the proper sheath of the vessels.

RELATIONS OF THE FEMORAL ARTERY.

In front.—Skin, superficial fascia, crural branch of genito-crural and branches of anterior crural, sartorius, long saphenous nerve and vein, aponeurosis of Hunter's canal.

Inside. — Femoral vein at upper part, adductor longus, sartorius.

Femoral Artery

Outside. — Vastus internus, long saphenous nerve and femoral vein at lower part.

Behind.—Psoas, pectineus and nerve to it, profunda vessels, adductor longus, femoral vein, adductor magnus.

The *Femoral Vein* has three relations to the artery. Commencing below, where the popliteal ends, the vein is first on the outer side, then ascends behind, and near Poupart's ligament is close to the inner side of and on the same plane with the artery, being separated from it by a thin fibrous partition. Frequently a large superficial vein ascends for some distance directly over the artery to empty either into the internal saphenous or into the femoral vein itself.

That part of the artery which is about an inch and a half to two inches long from Poupart's ligament to its division, is called the *common femoral*, and its two terminal branches are respectively, the superficial and deep femorals.

The *Common femoral* gives off some small superficial branches to the fascia, skin, and glands of the groin. These are the *superior, and inferior, or superficial, and deep external pudic, the superficial epigastric and the superficial circumflex iliac.* The profunda femoris and superficial femoral are its large terminal divisions.

The branches of the *superficial femoral* are several *muscular* offsets and the *anastomotica magna*; and the branches of the profunda are the *external and internal circumflex and perforating.* These will be subsequently dissected.

The cutaneous offsets have been seen in the superficial dissection of this region with the exception of the inferior external pudic which is at first placed beneath the fascia lata.

The *Inferior External Pudic* is the most deeply placed of the cutaneous branches of the common femoral (it may be given off from the superficial femoral), and passes inwards on the pectineus muscle to pierce the fascia lata and supply the skin of the inner border of the thigh and the

scrotum or labium, and anastomoses with branches of the superficial perineal artery. It may arise in common with the superior external pudic, and it usually pierces the fascia lata near the pudic ramus.

The **Deep Femoral**, or **Profunda Femoris**, nearly equals the superficial femoral in size, and arises from the outer and back part of the common femoral, usually from one to two inches below Poupart's ligament. It is at first on the outer side of the superficial femoral, and then passes to the inner side of the femur behind the femoral artery and vein, and ends at the lower third of the thigh in a small branch which pierces the adductor

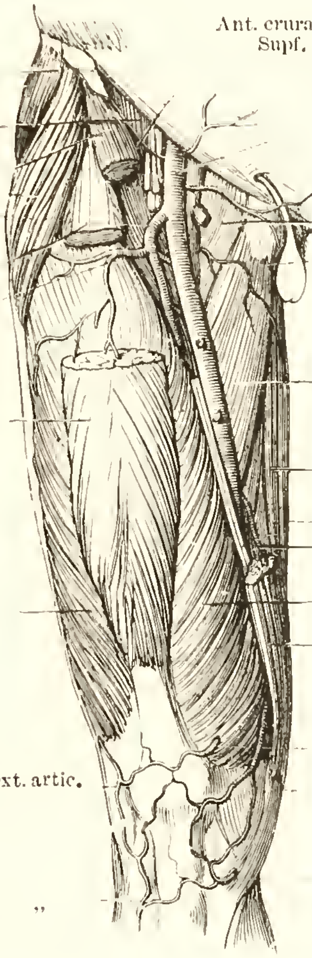


FIG. 270.—RIGHT FEMORAL AND PROFUNDA ARTERIES AND ARTICULAR OF POPLITEAL.

The antr. crural nerve, sartorius, and rectus are cut away.

magnus, and after supplying the hamstring muscles, anastomoses with the inferior perforating and upper articular branches of the popliteal. It is the principal nutrient vessel of the thigh, and will be dissected presently.

Varieties of the Femoral Artery and its Branches.—Four or five cases in which the superficial femoral divided into two vessels and subsequently became reunited near the adductor opening to form a single popliteal artery are recorded. Much interest is attached to this anomaly from the fact that it was met with by Sir Charles Bell during the course of an operation for ligature of the femoral for popliteal aneurism. The late Mr.

Nunnely of Leeds recorded in the 'Lancet' about twelve years ago, an interesting case of fracture of the neck of the femur, with double femoral artery, giving rise to anomalous and very interesting symptoms. It is not, to my knowledge, stated if this double condition of the vessels existed on both sides in the above mentioned cases.

Change of Position.—Four instances in which the femoral artery was replaced at the back of the thigh by a trunk continuous with the internal iliac, have been recorded. This unusual vessel accompanies the great sciatic nerve to the popliteal space and leaves the pelvis through the great sacro-sciatic foramen. Its relations in the ham are similar to those of the normal vessel.

Anomalies of the Branches.—The deep femoral is sometimes given off from the inner side, and more rarely from the back of the common femoral. It may be given off nearer to, or further from, Poupart's ligament than its usual position. In one case recorded by R. Quain it commenced above Poupart's ligament, and in another four inches below it, but in the latter instance the circumflex arteries were not given off by the profunda, but from the superficial femoral. When given off opposite to or above Poupart's ligament it is a branch of the external iliac which divides into superficial and deep femoral, the common femoral being wanting.

Many *occasional* branches, such as the deep epigastric, or aberrant obturator, have been seen to be given off from the femoral; and as rarities the accessory deep femoral, the accessory external circumflex, a dorsalis penis or ilio-lumbar may be derived from it. The *great saphenous artery* is an occasional large vessel, and when present comes off either above or below the origin of the profunda, and passes at first between the adductor magnus and vastus internus, then pierces Hunter's canal to reach the inner side of the knee and accompanies the long saphenous vein to the inner malleolus.

Surgical Anatomy.—The femoral may be readily compressed just below Poupart's ligament where the artery is very superficial. The pressure may be either digital or by means of a tourniquet, and must be directed backwards, at the upper part of Scarpa's triangle, but outwards against the shaft of the femur, in the middle third of the thigh. If the *common femoral* be tied, the main collateral channels for re-establishing the circulation, are the anastomoses of the ascending branches of the external circumflex below, with the descending branches of the gluteal and circumflex iliac arteries above and on the outer side; on the inner side the ascending branches of the internal circumflex below, join the descending branches of the obturator and sciatic above, to the inner side, and behind. At the back of the thigh, the comes nervi ischiatici branches of the sciatic descend to join the superior articular vessels of the popliteal, and also unite with the perforating; and, on the outer side, the external circumflex also joins the ilio-lumbar which comes from the posterior division of the internal iliac.

After ligature of the superficial femoral artery, circulation is maintained by the descending branches of the external circumflex anastomosing with the external articular branches of the popliteal and with some enlarged muscular vessels, also with the anastomotica magna through the superior external articular, and blood may reach the anterior tibial recurrent artery from the external circumflex by means of an anastomosis with the external

articular artery. The descending branches of the internal circumflex anastomose with the superior internal articular, with the termination of the profunda, and with enlarged muscular arteries; and the termination of the profunda may help to bring the blood into the leg by its anastomoses with the superior external articular. The comes nervi ischiatici also aid greatly in re-establishing the circulation.

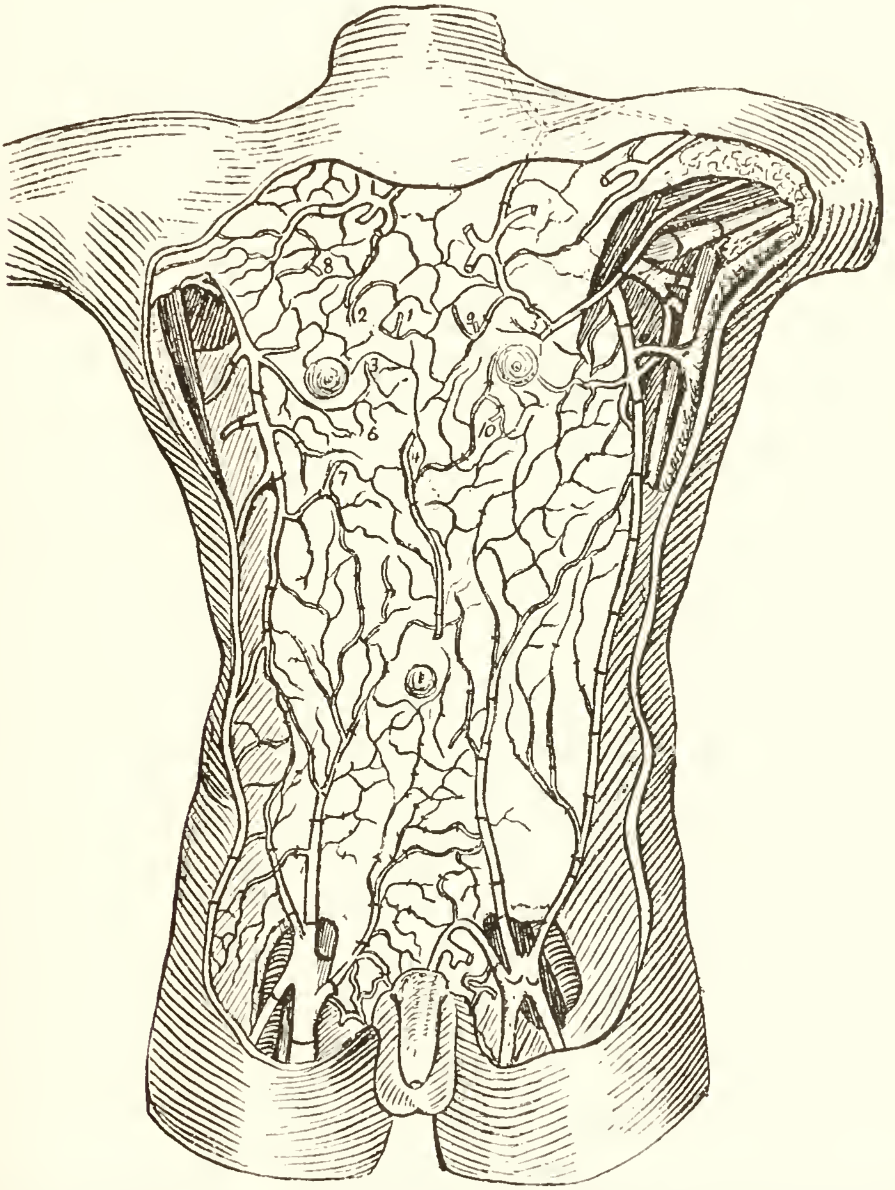


FIG. 271.—DISSECTION SHOWING THE ANASTOMOSES OF THE AXILLARY AND FEMORAL VEINS WITH THE SUPERFICIAL ABDOMINAL VEINS, AND OF THESE (AT THE PLACES NUMBERED) WITH THE DEEPER ABDOMINAL AND THORACIC VEINS. THE TRANSVERSE LINES INDICATE THE POSITION OF THE VALVES. I HAVE SHOWN IN DOTTED OUTLINE THE JUNCTION OF THE UPPER VEINS WITH THE CERVICAL VEINS ON THE LEFT.

From Mr. E. Hurry Fenwick's exhibits at the recent International Medical Congress.

The **Femoral Vein** is the principal vein of the lower limb, and in Scarpa's triangle has the same relations as the artery. It is on the inner side of the artery, and on the same plane with it near Poupart's ligament,

but it soon passes beneath it, and at the upper border of the adductor longus is placed to its outer side, and continues in this position until it becomes the popliteal vein. It receives the deep femoral and internal saphenous veins, and the inferior external pudic vein. The vein is sometimes placed internal to the artery in its entire length, or it may be double. The anomalies of this vein will be given subsequently.

DEEP PARTS ON THE FRONT OF THE THIGH.

Dissection.—An incision is to be carried along the middle of the front of the thigh, if this have not previously been done, and the skin, superficial and deep fasciæ must also be divided and reflected. The incision should reach to the tubercle of the tibia. The dissector must observe the attachment of the fascia lata to the sides of the patella forming its alæ or wings, and also its junction with the prolongations from the tendon of the quadriceps extensor muscle.

The sartorius crossing the thigh from without inwards, and the tensor fasciæ latæ at the upper and outer part of the muscles which combine in the quadriceps or triceps extensor should be dissected, also some of the branches of the profunda artery and of the anterior crural nerve.

In dissecting the sartorius, the nerves in contact with its surfaces, and especially a plexus beneath it at the middle of the thigh which may be called the *mid-femoral plexus*, should be preserved. A branch of the internal cutaneous, and of the anterior crural crossing over it below its middle, and another along the inner edge of the muscles below its middle, should be dissected, and the trunk of the great saphenous nerve issuing from beneath it near the knee, also its patellar branch piercing the muscle rather higher up must be taken care of. The nerves to the *mid-femoral plexus*, from the internal saphenous, internal cutaneous and obturator, should be traced out beneath the sartorius. The anterior surface of the adductors will be found internal to the sartorius, and the triceps extensor external to it. The knee should be bent in dissecting the sartorius, and an expansion from it to the fascia lata, and to the inner side of the knee, is to be preserved.

The *Tensor Fasciæ Latæ* at the upper and outer part of the thigh, with a strip of the fascia lata of the same width as the muscle, should be cleaned and left on the outer side of the thigh. One or two transverse incisions should be made through the remains of the fascia lata on the outer side, and the attachments of this fascia to the femur should be made out.

The **Sartorius** is the longest muscle in the body, and passes from the pelvis over the hip and knee joints to the tibia. It is a flat muscle *arising* by tendinous fibres from the anterior superior iliac spine and upper half of the notch below it. It lies in a hollow between the extensors on the outer and the adductors on the inner side, and obliquely crosses the upper and anterior part of the thigh from the outer to the inner side, then descends vertically as far as the inner side of the knee, passes behind the internal femoral condyle, and ends in a thin tendon below the knee which curves obliquely forwards and expands into a broad aponeurosis, which is *inserted* into the upper part of the inner surface of the shaft of the tibia nearly as far forwards as the crest, and also by its upper edge as far back as the

internal lateral ligament of the knee.' This expansion covers the insertions of the gracilis and semitendinosus, being partly united to them, and partly separated by a synovial bursa. An expansion from the upper margin of the sartorius aponeurosis blends with the fibrous capsule of the knee, and another from its lower border is continuous with the deep fascia on the inner side of the leg.

Relations.—It is superficial throughout, and is pierced by some cutaneous vessels and nerves. In the upper third of the thigh it forms the *outer boundary* of Scarpa's triangle. In the middle-third of the thigh the superficial femoral artery lies along its *inner border* and then passes

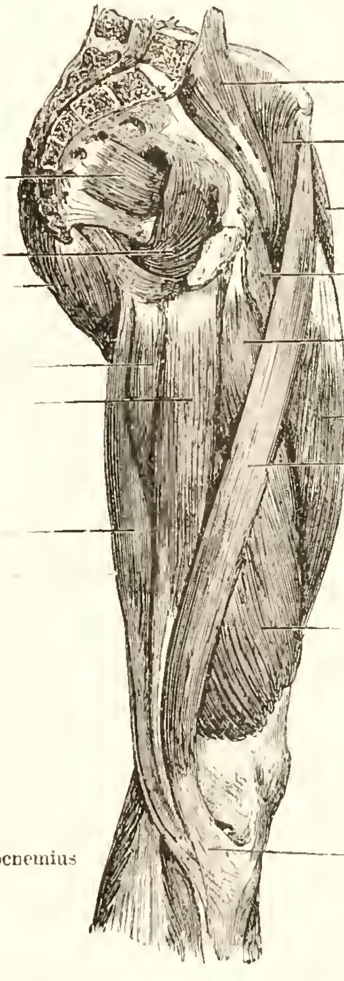


FIG. 272.—MUSCLES OF THE LEFT THIGH. INTERNAL VIEW.

behind the muscle. Its *superficial surface* is in relation with the skin, deep fascia and long saphenous vein; its *deep surface* with the iliacus, psoas, rectus, vastus internus, anterior crural nerve, femoral sheath, adductor longus, adductor magnus, gracilis, long saphenous nerve and its patellar branch, and internal lateral ligament of the knee. Below the adductor opening for the femoral artery it bounds the popliteal space internally and is placed between the vastus internus and adductor magnus in front, and the gracilis, semi-tendinosus and semi-membranosus behind.

Action.—It flexes the knee and hip joints, and rotates the tibia *in-*

wards. It can also adduct the leg, crossing one over the other. Acting from below, it flexes the pelvis on the thigh, and one muscle acting alone assists in rotating the pelvis. It is also a tensor of the deep fascia of the thigh and leg, and supports the pelvis on the femoral head in standing.

Nerve.—Anterior crural.

Varieties.—It is frequently divided into two parts which have a similar attachment, or the lower muscle may be inserted into the femur or into the tendon of the femoral muscle. Its insertion tendon may end in the fascia lata or the inner side of the knee capsule, which may be entirely absent. It is extremely rarely double, and it may have a tendinous intersection which may be closely adherent to the fascia lata.

Dissection.—To expose the superficial and deep femoral vessels and their branches, the sartorius should be divided about the junction of its upper and middle third and reflected. The structures enumerated in the following paragraph must be cleaned.

Position of Parts.—Beneath the sartorius will be found an aponeurosis which is thin above and which separates the extensors from the adductors.

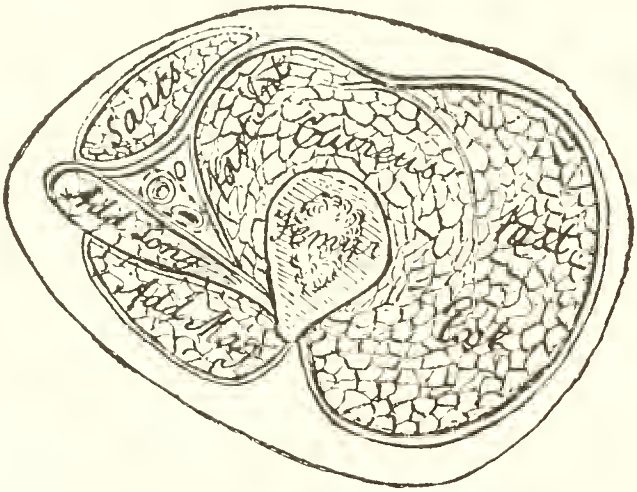


FIG. 273.—DIAGRAM OF TRANSVERSE SECTION THROUGH LEFT HUNTER'S CANAL.

The femoral artery and vein are seen in their sheath, and the long saphenous nerve is in the canal but outside the sheath.

The internal saphenous nerve is beneath it. The nerve to the vastus internus sending an off-set to the knee, lying on the surface of the muscle, will be found parallel to the upper and outer part of the saphenous nerve. The femoral or mid-femoral plexus on the inner side of the thigh will also be exposed.

The anastomotica magna branch of the superficial femoral should be traced through the fibres of the internal vastus in front of the tendon of the adductor magnus as far as the knee, also a twig from it accompanying the long saphenous nerve. These will be found in the lower third of the thigh.

The *Aponeurotic Sheath for the femoral vessels* (*Hunter's Canal*) only exists where the vessels are overlaid by the sartorius. It consists of a strong fibrous band passing transversely between the vastus internus and the tendons of the adductors longus and magnus. It is thin above, but

below is composed of strong fibres which cease at the opening in the adductor magnus where its border is defined, and beneath which the long saphenous nerve and satellite vessels escape. The adductor opening is a good deal larger than the structures it contains.

The *deeper part of the Superficial Femoral Artery* is contained in a

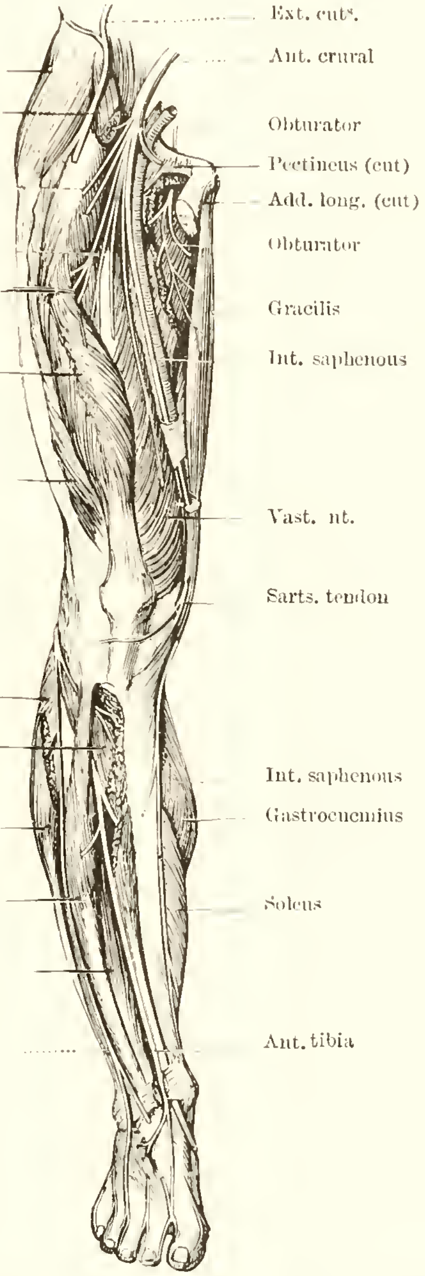


FIG. 274.—DEEP NERVES OF THE RIGHT LOWER LIMB AND THE FEMORAL ARTERY.

The sartorius, pectineus, adductor long., and tibialis anticus are cut and the rectus is drawn aside.

muscular hollow bounded externally, by the vastus internus, and internally, by the adductor magnus and longus, and covered in by the aponeurotic covering just described. On vertical transverse section this canal is triangular, with its base at the aponeurosis. In the canal the femoral vein lies on the *outer side* of the artery, but close to it, and *still more external*

is the long saphenous nerve which, although in the canal, is not within the sheath of the vessels.

Branches.—A few unnamed muscular twigs and the anastomotica magna arise from this part of the artery.

The *Anastomotica Magna* is given off from the femoral in Hunter's canal just before it passes through the tendinous opening in the adductor muscle. It at once divides into a superficial and deep branch.

The *Superficial Branch* pierces the anterior wall of the canal and accompanies the saphenous vein to the lower border of the sartorius, and perforating the fascia lata, ends in the skin.

The *Deep Branch* runs in the fibres of the vastus internus, lying in front of the tendon of the adductor magnus, to the inner side of the knee, where it anastomoses with the superior internal articular branch of the popliteal, and the recurrent articular branch of the anterior tibial. It gives off a branch which crosses outwards in the substance of the vastus

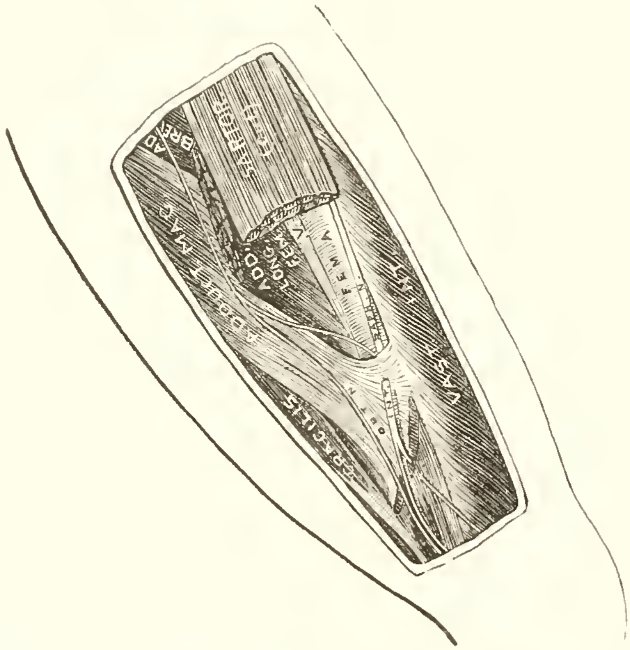


FIG. 275.—DISSECTION OF LEFT HUNTER'S CANAL.

internus above the articular surface of the femur and anastomoses with an offset of the superior external articular artery, forming an arch, from which branches are distributed to the front of the knee.

The *Muscular Branches* come chiefly from the outer side of the artery and supply the vastus internus, adductor longus, and sartorius.

The **Femoral Vein** in this part of its course is external to the artery, and has similar relations to it, receiving branches corresponding to those of the artery.

Variety.—This vein may pierce the adductor magnus above the usual place, and joining the deep femoral vein approach the femoral artery at the groin. It may be doubled in its whole length, or only in a small part of its course. In rare cases the two veins which are united to form the femoral are joined by three or four transverse branches in front of the femoral artery, and in other instances there are three or four largish

veins, which only join near Poupart's ligament to form a common femoral vein.

The **Tensor Fasciæ Femoris** is a short flat muscle placed at the outer and upper third of the thigh. It is the most external and smallest of the outer group of muscles, and *arises* from the anterior portion of the outer lip of the iliac crest, from the outer aspect of the anterior superior spinous process, and from the upper part of the notch between it and the inferior spine. At its origin it is between the sartorius and gluteus medius, and its fibres form a fleshy belly about two inches wide which

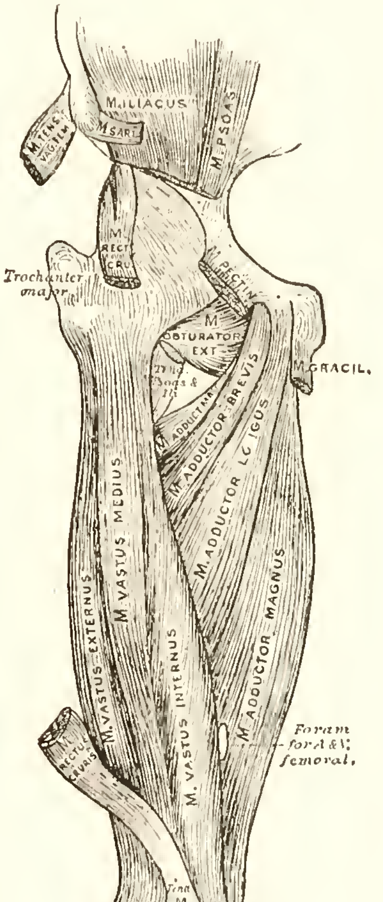


FIG. 276.—MUSCLES OF THE FRONT AND INNER SIDE OF THE RIGHT THIGH.

passes obliquely down and back, to be *inserted* between the layers of fascia lata about three inches below, and rather anterior to the great trochanter. The ilio-tibial band of the fascia lata may be considered as part of the insertion of this muscle.

Relations.—Superficially, with the skin and fascia lata; *deeply* with the gluteus medius, rectus, vastus externus, ascending branches of the external circumflex artery, and a branch of the superior gluteal nerve; *anteriorly*, with the sartorius and rectus; and *posteriorly* with the gluteus medius.

Action.—It abducts the thigh and renders tense the fascia lata. It assists in internal rotation of the femur. Acting from below it will support the pelvis on the femoral head and assist in balancing it in walking.

Nerve.—The superior gluteal, which enters its under surface.

Dissection.—Divide the artery and vein below the origin of the profunda femoris, and throw them downwards. Remove the veins and fatty tissue from the anterior crural nerve and from the branches of the profunda. The process of the fascia lata extending from the tensor to the knee should be cut, and separated from the neighbouring muscles. This dissection will enable the upper part of the inner vastus and the head of the rectus to be traced out.

The **Triceps Extensor Cruris**, or **Quadriceps** of some authors, consists of three parts, one of which, the rectus femoris, is distinct, and descends from the hip bone, while the two others are distinguished by the arrangement of their fibres and cover the whole of the anterior and lateral surfaces of the femur, from which they arise. The three parts or heads composing this muscle are the outer, formed by the vastus externus, the middle, formed by the rectus, and the antero-internal, formed by the crureus and vastus internus. Inferiorly these muscles unite into a single tendon which is attached to the tibia. They envelope the femoral shaft from the condyles to the trochanters. The rectus femoris, or middle head of the triceps extensor, forms a fleshy prominence on the front of the thigh, is fusiform, and arises by two tendons or heads, an anterior or short head, and a posterior or long head. The anterior *arises* from the anterior inferior iliac spine, and the posterior (which will be subsequently dissected) from a depression above the brim of the acetabulum. The long or reflected head joins the straight tendon at an acute angle about an inch from its origin, and separates into an aponeurosis from which the muscular fibres arise in a penniform manner. These turn outwards and backwards as they descend, and are inserted in a similar manner into the inferior tendon, which is prolonged on the posterior surface of the muscle, while the superior tendon is prolonged on its anterior aspect. The inferior tendon becoming narrow and flattened, is *inserted* into the upper border of the patella and through the ligamentum patellæ into the tubercle of the tibia. The lower tendon occupies the inferior two-thirds of the posterior surface of the muscle, and sends a strong prolongation to the upper and anterior part of the great trochanter. It is connected with the iliotrochanteric band of the hip capsule, and is rendered tense in external rotation of the femur.

Relations.—*Superficially*, with the anterior fibres of the gluteus minimus, the tensor fasciæ femoris, sartorius, outer borders of psoas and iliacus, and with the fascia lata. *Posteriorly*, with the hip-capsule, the external circumflex vessels, branches of anterior crural nerve, the vasti, and crureus.

Some authors have described the vasti and crureus under the name of *triceps extensor*, but the description already given will be adhered to as the more natural one.

Nerve.—The anterior crural.

Variety.—It may have an external origin from the anterior superior spine, or its acetabular head may be absent.

Dissection.—Divide the rectus near its lower end and reflect it, care-

fully preserving the branches of vessels and nerves beneath it. Some descending vessels and nerves will indicate the point of separation between the external vastus and the crureus and vastus internus. The separation of these muscular masses at the mid-part of the outer aspect of the thigh, is indicated by the long vertical fibres of the external vastus passing to their tendon, crossing over the deeper fibres which pass obliquely inwards, and are a part of the internal vastus.

The **Vastus Externus** *arises* by an extensive aponeurosis from the base of the great trochanter in front, from the tubercle and anterior border of the same bony process, from the horizontal ridge on its outer surface, and from a rough line passing between the linea aspera and great trochanters, also from the whole length of the outer lip of the linea aspera. This aponeurosis covers the upper three-fourths of the muscle and gives origin to many muscular fibres. A few fibres also arise from the external intermuscular septum, between the vastus externus and short head of the biceps, also from the tendon of the gluteus maximus. Its origin from the femur is narrow as compared with its thickness and size. Its fibres form a rhomboidal mass, which is attached to a strong aponeurosis on the under surface and lower part of the muscle, and which descends obliquely inwards and forwards, on the outer surface of the vastus internus, and becomes thickened and contracted into a flat tendon which joins the outer border of the tendon of the rectus, and is attached to the outer border of the patella, giving an expansion over the outer side of the knee joint. It is pointed above, but broad and thick below, forming the prominence on the outer side of the thigh.

Relations.—Superficially, with the rectus, tensor fasciæ femoris, gluteus maximus, from which it is separated by a bursa and fascia lata. *Deeply*, with the crureus, being separated from it by the descending branches of the external circumflex artery, and anterior crural nerve.

Nerve.—The anterior crural.

Variety.—It may be bi-laminar, as in birds.

Vastus Internus.—The vastus internus and crureus are inseparably united and form the deep or inner head, and smallest portion of the triceps extensor. The anterior part covered by the rectus is called the *crureus*. The inner portion which is beneath the fascia lata is the vastus internus. The fibres of this portion may be easily separated into a superficial and deep set. The former is a continuous lamina over the front and both sides of the femur, completely enclosing the deeper fibres, and it descends in different directions. The anterior or middle fibres arch forwards almost parallel to the femur, and the lateral fibres, both inner and outer, are more oblique, and at the lower part of the muscle they are almost horizontal. The anterior fibres *arise* from the middle of the anterior intertrochanteric line, and the inner lateral fibres come from a line passing from the anterior inter-trochanteric line in front of the small trochanter, to the inner line leading to the linea aspera, from the lower half of that line, from the inner lip of the linea aspera, and from the inner intermuscular septum. The outer lateral fibres *arise* from the anterior intertrochanteric line and from the outer surface of the shaft of the femur immediately in front of it, being closely connected with the origin of the external vastus. The lower external lateral fibres reach some distance beyond the lower border of the vastus externus and arise from the outer

lip of the linea aspera, and from the external intermuscular septum. The fibres converge from this extensive origin, which is partly aponeurotic, to the under surface and margins of a flat tendon which runs upwards chiefly on the surface of the anterior portion of the muscle. Inferiorly, this

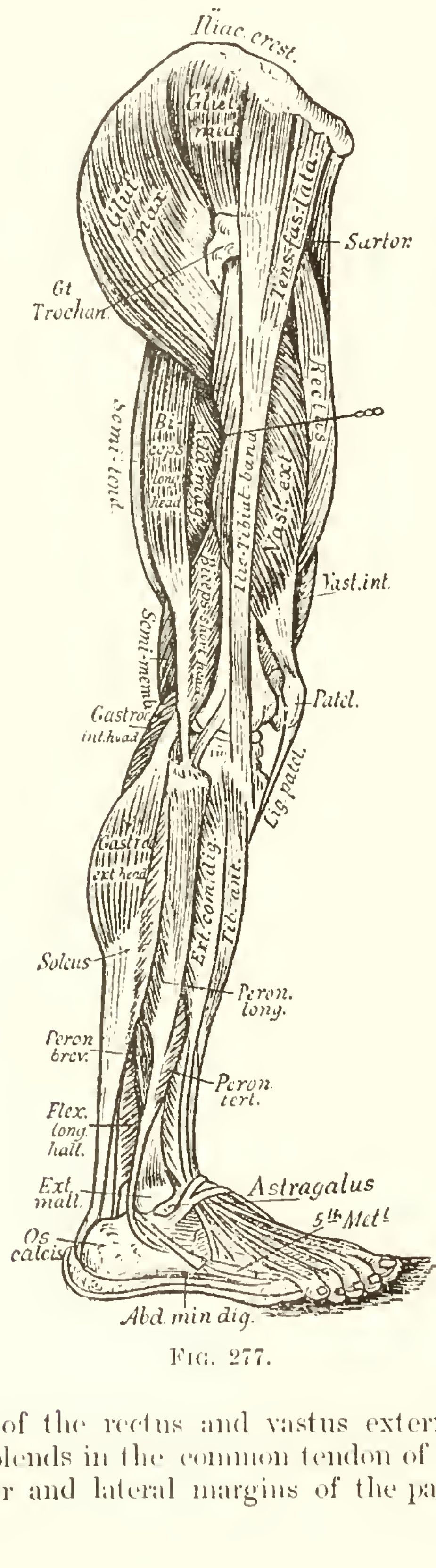


FIG. 277.

tendon joins those of the rectus and vastus externus, and ends in an aponeurosis which blends in the common tendon of insertion and is inserted into the upper and lateral margins of the patella, lower than the

vastus externus. Many of the lowest outer and inner lateral fibres are attached directly to the sides of the patella and to the fascia lata at the sides of the knee.

The deep set of fibres which may be called the *crureus*, *takes origin* from about the middle two-thirds of the anterior aspect only of the femoral shaft. Its lower part reaches to within two or three inches of the articular surface, and its origin is separated by a slight interval from that of the superficial fibres. The fibres of this set pass obliquely down and forwards and are inserted into the posterior aspect of the tendon of the superficial fibres. There is a longitudinal band on the lateral surfaces of

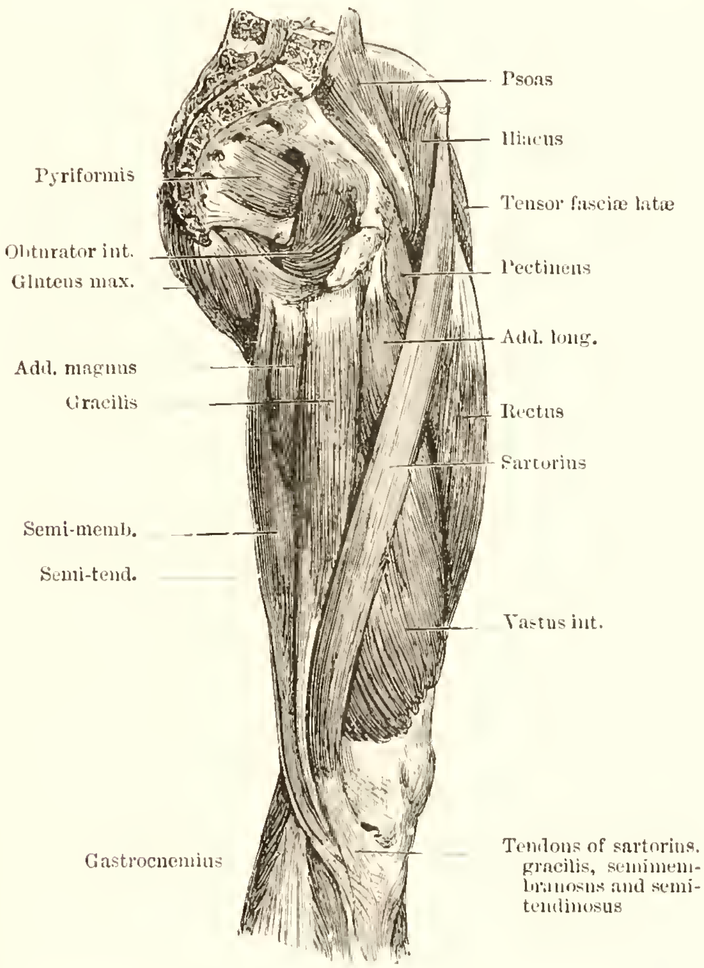


FIG. 278.—MUSCLES OF THE LEFT THIGH. INTERNAL VIEW.

the femur on each side of the origin of this portion of the muscle, which is free from muscular attachment. This band varies in breadth in different subjects, and is broader on the inner aspect of the femur. It will thus be noted that the internal vastus *arises* from nearly the whole of the anterior, external, and internal surfaces of the femoral shaft, from the anterior inter-trochanteric line to within the lower fourth of the bone, and that its different fibres converge to a broad aponeurosis which is on the anterior surface of the middle portion of the muscle, and which covers the deep surface of its inner division (the vastus internus).

Relations.—*Anteriorly*, with the rectus, sartorius, femoral vessels,

anterior crural, and saphenous nerves; *posteriorly*, with the femur, subcrureus, and synovial membrane of the knee. On its *outer surface* is the vastus externus, and along its *inner border* are the psoas, iliacus, and the femoral artery and vein, and it is closely connected with the adductors along the linea aspera, being firmly united to the adductor magnus by the aponeurosis which forms Hunter's canal.

Variety.—It may be bi-laminar.

Nerve.—The anterior crural.

Dissection.—To expose the tendon of this extensor, a thin aponeurotic layer which is continuous with the lower fleshy fibres of the muscle, and which covers the anterior and lateral aspects of the knee joint, must be divided along the middle line as far as the tubercle of the tibia. If a transverse cut be made at the latter situation and this aponeurosis be reflected outwards and inwards the tendon will be apparent.

The **Tendon of these Extensors** of the leg is common to all these muscles, and is formed by the union at the lower part of the thigh, of the tendons from the different portions of the muscle. It passes in front of the knee, acting as an anterior ligament to the joint. The tendinous expansions from these different muscles are partly inserted into the upper part and sides of the patella, but beyond it they form a thickish flat tendon which is really inserted into the tubercle of the tibia, the patella being a sesamoid bone developed in the tendon of the triceps femoralis. This tendon is wide above where the muscular fibres end. Over the joint it narrows, and below is *inserted* into the lower part of the tubercle of the tibia and into the tibia itself an inch below it. A bursa is interposed between the upper part of the tibial tuberosity and the tendon. From the tendons of the vasti a superficial aponeurotic expansion is derived which is united with the fascia lata which forms a capsule protecting the knee joint, and which is attached below to the heads of the tibia and fibula. From these expansions a few scattered aponeurotic fibres cover the anterior surface of the patella, but there are none on its articular aspect. The fibrous prolongation from the vastus internus is the strongest, and the fibrous capsule of the knee is strengthened on the outer side by the fascia lata. The direction of this tendon is rather obliquely down and out to the tibial tubercle.

If the student have previously dissected the arm he will be struck with the analogy that exists between the triceps brachialis and the triceps femoralis. The latter has three divisions or heads like the former, an outer and inner head, and a middle, or long head, which is attached to the pelvic girdle, similar to the long head of the arm muscle which is attached to a part of the shoulder girdle.

The **Sub-Crureus** is a small muscular layer of pale fibres which is usually distinct from the crureus, but may be blended with it and the vastus internus. Some consider it to be a part of the inner vastus, separated from the rest by areolar tissue. It *arises* from the anterior surface of the lower part of the femoral shaft, often by an outer and inner slip, and is *inserted* by scattered aponeurotic fibres into the upper part of the supra-patellar pouch of the synovial membrane of the knee.

Varieties.—It is often double, or may consist of two separate muscular bundles.

Nerve.—The anterior crural.

Action.—The three heads of the common extensor of the leg extend the knee joint, but its action is not essential to maintain the erect attitude, as the knee joint remains in complete extension without muscular assistance when the foot is firmly placed on the ground. The student may be convinced of this by feeling his patella while standing with the knee extended. It will be then found to be quite loose, and to be movable laterally, as

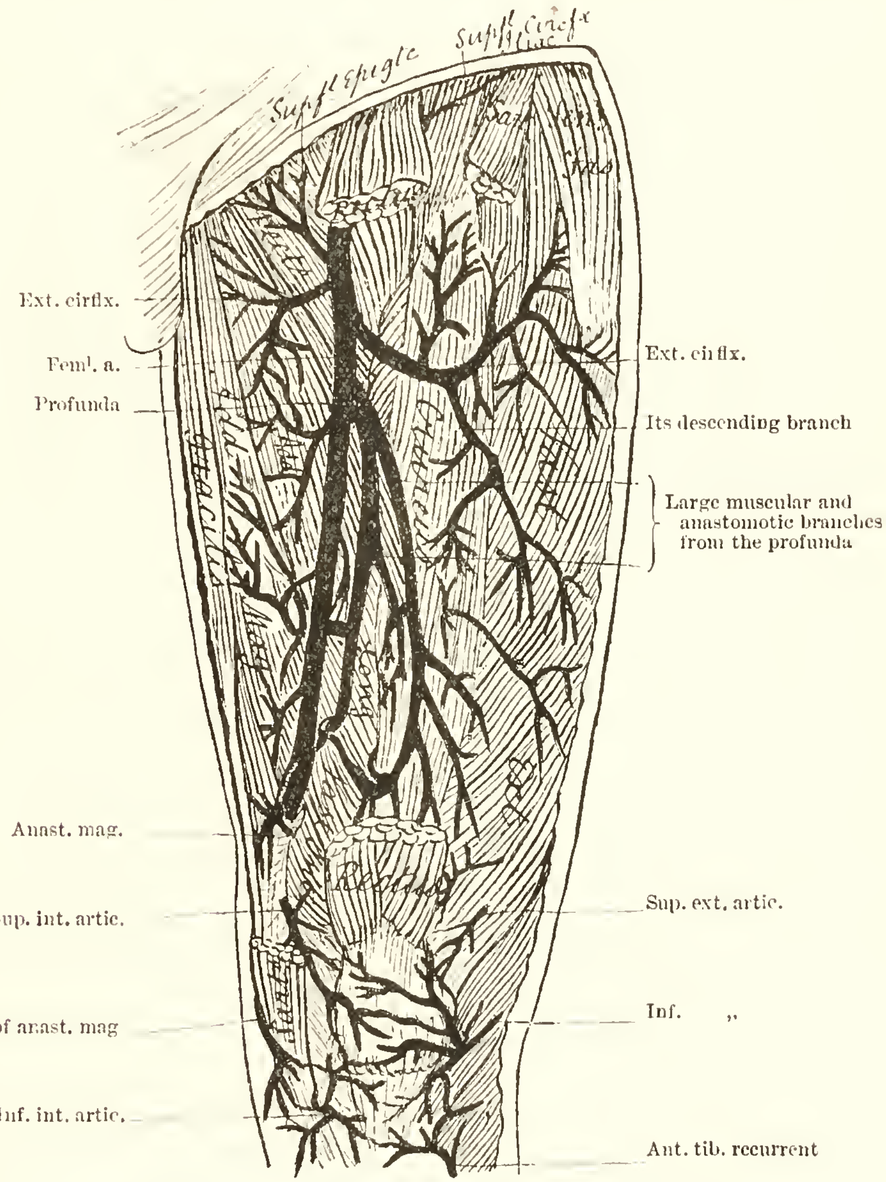


FIG. 279.—DISSECTION OF THE LEFT FEMORAL ARTERY AND ITS BRANCHES.

The circumflex come off from the superficial femoral, and the profunda is given off unusually low down.

well as up and down, but directly he raises his foot from the ground it will at once become fixed.

The rectus extends the knee and flexes the hip, over which it passes. Its anterior head acts when the thigh is extended, and the posterior when the thigh is bent.

Acting from below the triceps will draw the femur forwards and straighten the knee, supporting the femur perpendicularly on the tibial

head, and maintaining the body weight in walking or standing. The rectus can assist the psoas and iliacus in flexing the pelvis on the femur, or in supporting it on the femoral head.

The sub-crureus contracts when the knee is extended and pulls the synovial membrane up out of the way of the joint surfaces.

The *Inter-Muscular Septa* have already been described, but the student should now make himself familiar with their attachments. As already stated they separate the muscles in the front from those at the back of the thigh, and are attached to the outer and inner lips of the linea aspera, and to the lines leading from it to the femoral condyles, and bind the fascia lata to the femur in the lower part of the thigh.

The *Internal Septum* is much thinner than the external, and is attached to the femur between the adductors and the vastus internus. It is very thin along the border of the internal vastus, and between the linea aspera and inner condyle it is strengthened or supplanted by the tendon of the adductor magnus. The superior internal articular vessels pass through it to the front of the knee, and the deep branch of the anastomotica magna, accompanied by the branch to the knee from the nerve to the inner vastus, passes down on the septum.

The *External Septum* is the stronger, and is inserted into the linea aspera from the outer condyle to the lower border of the tendon of the gluteus maximus between the short head of the biceps and the vastus externus and internus. It is pierced near the condyle by the superior external articular vessels and nerve, and gives origin to the short head of the biceps.

The **External Circumflex Artery** is larger than the internal, and supplies the muscles in front of the thigh. It is given off from the outer side of the profunda near its origin, and passes transversely outwards beneath the sartorius and rectus muscles, and through the divisions of the anterior crural nerve to the outer part of the thigh, where it divides into three sets of branches; ascending, transverse, and descending.

The *Ascending Branches* pass up beneath the sartorius, rectus, and tensor fasciæ femoris, to the outer side and back of the hip, and anastomoses with the terminal branches of the gluteal and with some of the external descending branches of the circumflex iliac artery.

The *Transverse Branches* are the smallest and least numerous; they pass out over the crureus, pierce the outer vastus, so as to get between it and the femur, just below the back of the great trochanter, and at the back of the thigh anastomose with the internal circumflex and superior perforating branches of the deep femoral, and with the gluteal and sciatic branches of the internal iliac artery.

The *Descending Branches*, three or four in number, pass down and out on the extensors, but behind the rectus. Some of them are large and supply the muscles on the fore-part of the thigh, but one or two pass beneath the vastus externus as far as the knee to anastomose with the superior external articular branch of the popliteal. A small branch runs over this muscle with the nerve to the knee, which is given off by the nerve to the vastus externus.

Varieties.—The external circumflex sometimes arises directly from the femoral, or there may be two branches, one from the deep femoral and the other from the femoral itself. Both branches may arise from the

deep femoral, and as a rarity, both may come from the superficial femoral artery, or even from the common femoral.

The **Anterior Crural Nerve** is the largest branch of the lumbar plexus, and is derived mainly from the anterior primary divisions of the third and fourth lumbar nerves, having a fasciculus from the second. It supplies the iliacus, pectineus, and all the muscles of the front of the thigh, and most of the skin of the front and inner side of the thigh and of the leg and foot, and gives articular branches to the knee. Only the femoral

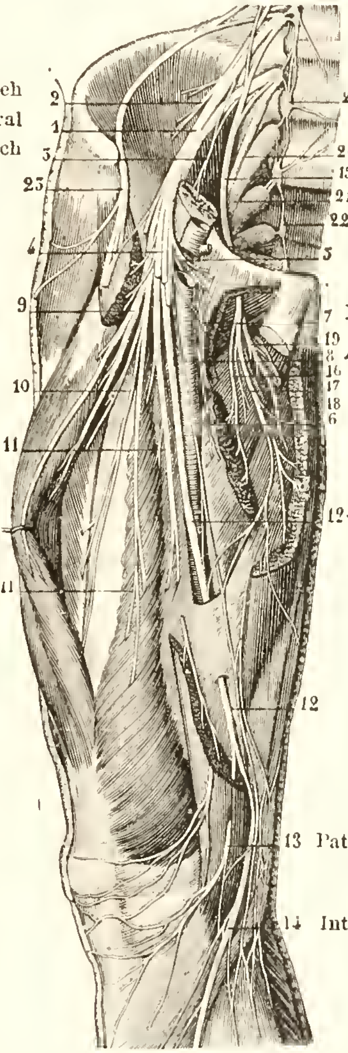


FIG. 280.—DEEP NERVES OF RIGHT THIGH. ANTERIOR VIEW.

16, 17, 18, 19. Branches of obturator to add. long., brev., and gracilis ; the latter divides and anastomoses with int. saph. and the deep branch of int. cut. 21. Lumbo-sacral joining first sacral.

part of the nerve is now dissected. It enters the thigh beneath Poupart's ligament, between the psoas and iliacus muscles, where it is somewhat flattened, and divides into an *anterior, superficial, or cutaneous*, and a *posterior, deep, or muscular part*, under Poupart's ligament. It is beneath the iliac fascia, and is separated from the femoral artery by the psoas muscle.

The Superficial Division gives off three branches, the *middle and internal cutaneous* and *internal saphenous* nerves.

The *Middle Cutaneous* perforates the fascia lata, and sometimes the sartorius also, about three inches below Poupart's ligament, and extends to the knee. It has already been dissected.

The *Internal Cutaneous* gives off two or more branches which pierce the fascia lata and supply the skin of the upper third of the thigh. It then divides in front, or to the inner side of the femoral artery, into an anterior and inner branch. Sometimes these branches are given off separately from the anterior crural.

The *Anterior Branch* lies over the sartorius as far as the middle of

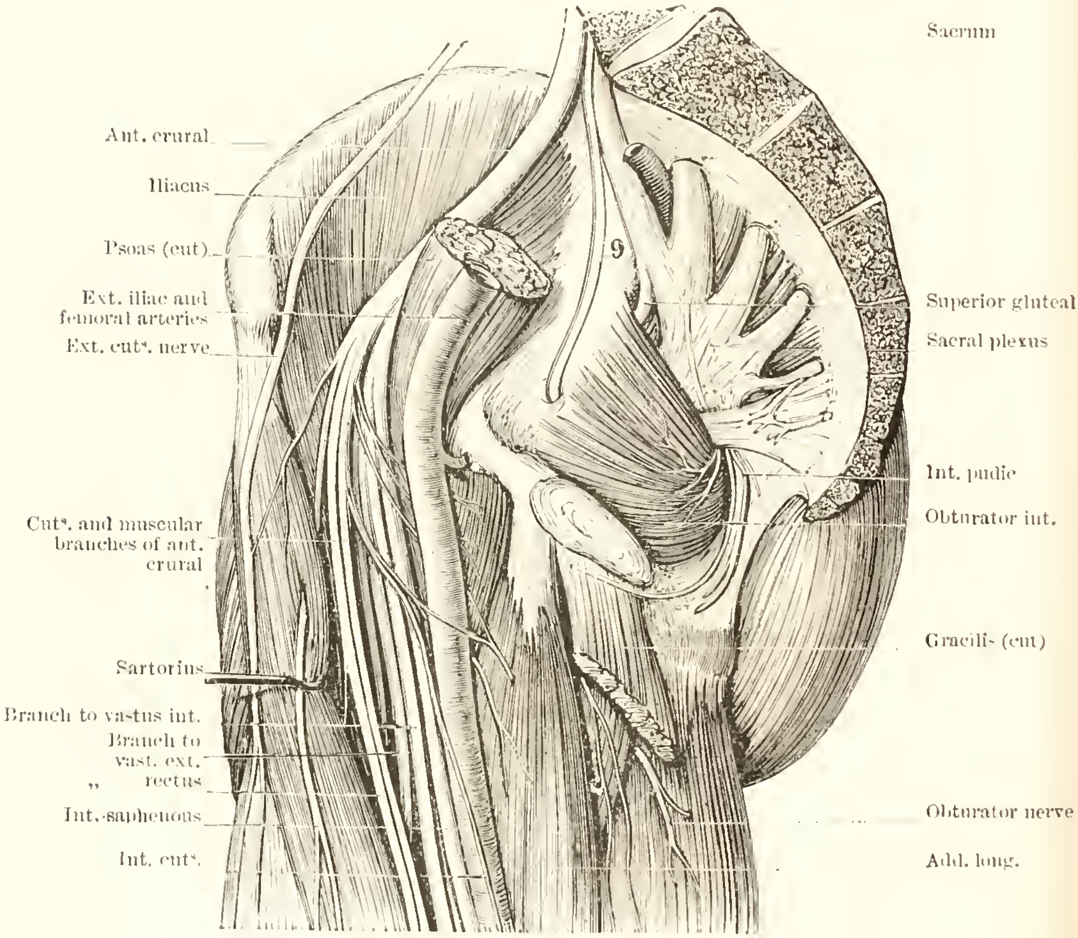


FIG. 281.—INNER VIEW OF RIGHT SIDE OF PELVIS, TO SHOW SOME OF THE BRANCHES OF THE LUMBAR AND SACRAL PLEXUSES.

It represents an antero-posterior vertical section in the mid-line. 9. Obturator nerve entering its foramen. The symphysis pubis is shown in section just below it. The sartorius is pierced by the middle cutaneous.

the thigh, and then pierces the fascia lata to supply the skin as far as the inner side of the knee. The *inner branch*, while beneath the deep fascia, runs along the inner border of the sartorius, and about the middle of the thigh joins in the femoral plexus. It is beneath the deep fascia as far as the knee, and near the knee it joins a branch of the internal saphenous nerve.

The **Internal Saphenous Nerve** is the largest branch of the superficial division of the anterior crural. It accompanies the femoral vessels, lying on their outer side, and is contained in Hunter's canal as far as the adductor

opening. At that point it leaves the aponeurosis and passes under the sartorius to the upper and inner part of the leg, the skin of which it supplies. It is then continued onwards to the foot. While beneath the

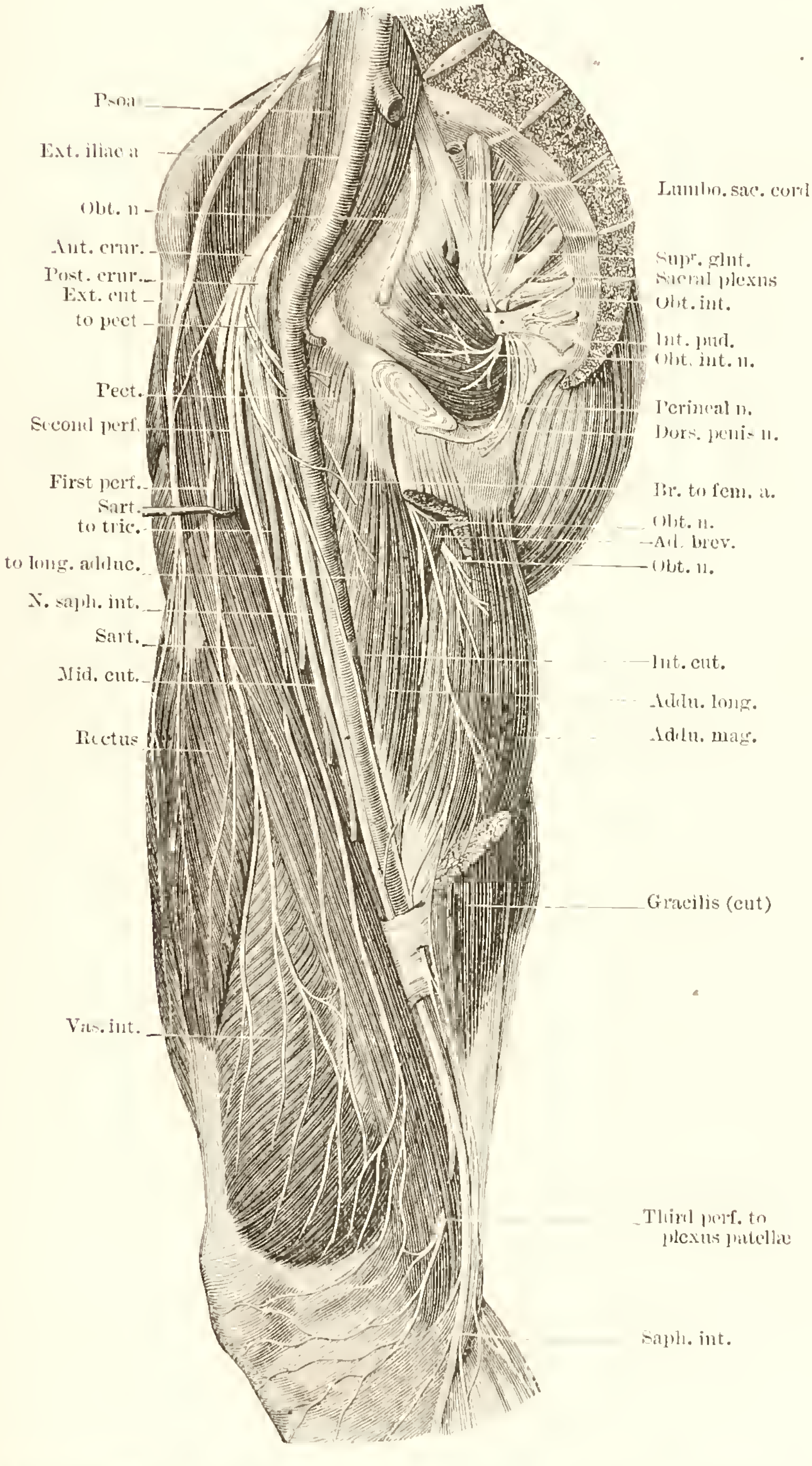


FIG. 282.—INNER VIEW OF NERVES OF RIGHT THIGH AND NERVES OF SACRAL PLEXUS.

The anterior and posterior crural are the supfl. and deep branches of the nerve, and the perforating are branches of the middle cut.

deep fascia it gives off two branches, a communicating, and a patellar branch.

Its *Communicating Branch* is given off about the middle of the thigh, and passes inwards beneath the sartorius to join the internal cutaneous and obturator in the femoral plexus, or it may join the internal cutaneous nearer the knee. This offset is frequently absent.

The *Patellar Branch* arises from the nerve near the inner side of the knee, and piercing the sartorius and fascia lata, joins in the præ-patellar plexus and supplies the skin over the inner side and front of the knee.

The *Deep, or Muscular Division* of the anterior crural nerve supplies all the muscles in the front of the thigh, and also the pectineus; but the pectineal branch sometimes arises from the superficial division of the nerve. The tensor fasciæ femoris is not supplied by the anterior crural, but, as before stated, by the superior gluteal nerve.

Muscular Branches.—The branch to the pectineus is a slender filament which passes to the anterior aspect of the muscle beneath the femoral artery. There may be two twigs to the muscle.

The *Sartorius* receives three or four twigs from the middle or internal cutaneous which supply mostly its upper part. The student will note that this muscle is supplied from the division of the nerve which is mainly cutaneous.

The *Rectus* has a separate branch which enters, by several filaments, the upper part of its anterior aspect.

The *Vastus Externus* has a branch of considerable size which accompanies the external circumflex artery to the lower part of the muscle. It divides into two or more branches as it enters the muscle, from one of which a long slender articular filament passes down to the knee, piercing its fibrous capsule on the anterior aspect.

The *Nerve to the Vastus Internus* is nearly as large as the internal saphenous, in common with which it often arises, and divides into two sets of branches which enter the vastus internus and crureus about the middle of these muscles. The nerve to the inner vastus gives filaments which enter the upper part and middle of the muscle, but before penetrating the muscular fasciculi gives a small branch to the knee.

The *Articular Branch* to the knee from the nerve to the inner vastus, passes on or in the muscle along the internal intermuscular septum with the deep branch of the anastomotica magna artery, resting on the tendon of the adductor magnus as far as the inner side of the knee where it pierces the capsular ligament and passes outwards on the synovial membrane beneath the ligamentum patellæ.

The *Nerve to the Tensor Fasciæ Femoris* comes from the superior gluteal, and after entering the under surface of the muscle extends nearly to its lower end.

The student must now proceed with the dissection of the parts on the inner side of the thigh, but before doing so he should thoroughly recapitulate the substance of the present section.

THE INNER SIDE OF THE THIGH.

In this dissection the student will become familiar with the three adductor muscles, with the gracilis, obturator externus, and the insertion of the psoas and iliacus. He will also dissect out the profunda artery and vein and their branches, also those of the obturator artery and nerve, the latter being found deeply situated amongst the adductors.

Dissection.—The skin, fatty tissue, and fascia must be removed from the muscles, and the adductors magnus and brevis should be separated

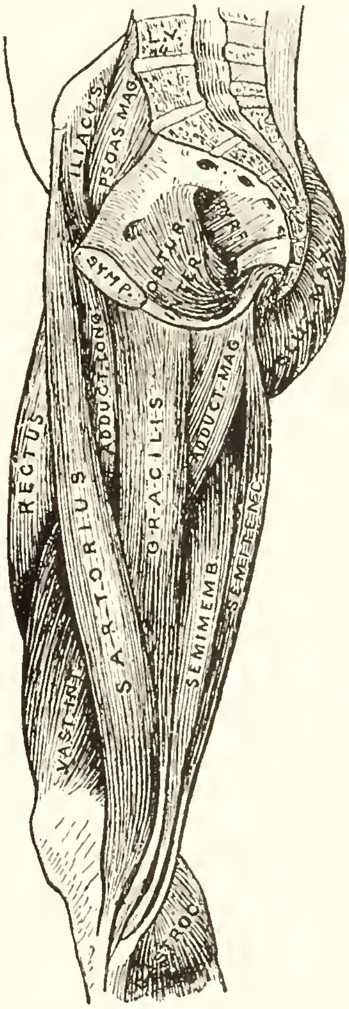


FIG. 283.—MUSCLES OF THE INSIDE OF THE RIGHT THIGH.

from each other, being careful of the branches of the obturator nerve which are beneath them, and especially of an offset which lies beneath the adductor magnus and goes to join the femoral plexus. The branches of the profunda artery and vein must also be cleaned.

The **Gracilis** is the most superficial muscle of the internal femoral region, and is a long slender riband-like structure, passing from the pelvis to the tibia. It is broad above and narrow below, and *arises* by a thin flattened tendon between two and three inches broad from the inner margin of the rami of the pubes and ischium along the lower half of the sym-

physis, and the upper part of the pubic arch. Its fibres pass vertically down and end in a round tendon which passes behind the inner femoral condyle, curves round the inner tuberosity of the tibia, and becoming flattened, is *inserted* into the upper part of the inner surface of the tibial shaft below the tuberosity, beneath and close to the sartorius with which it is blended, and is on the same plane with but higher up than the semitendinosus. It is separated from the internal lateral ligament by a syno-

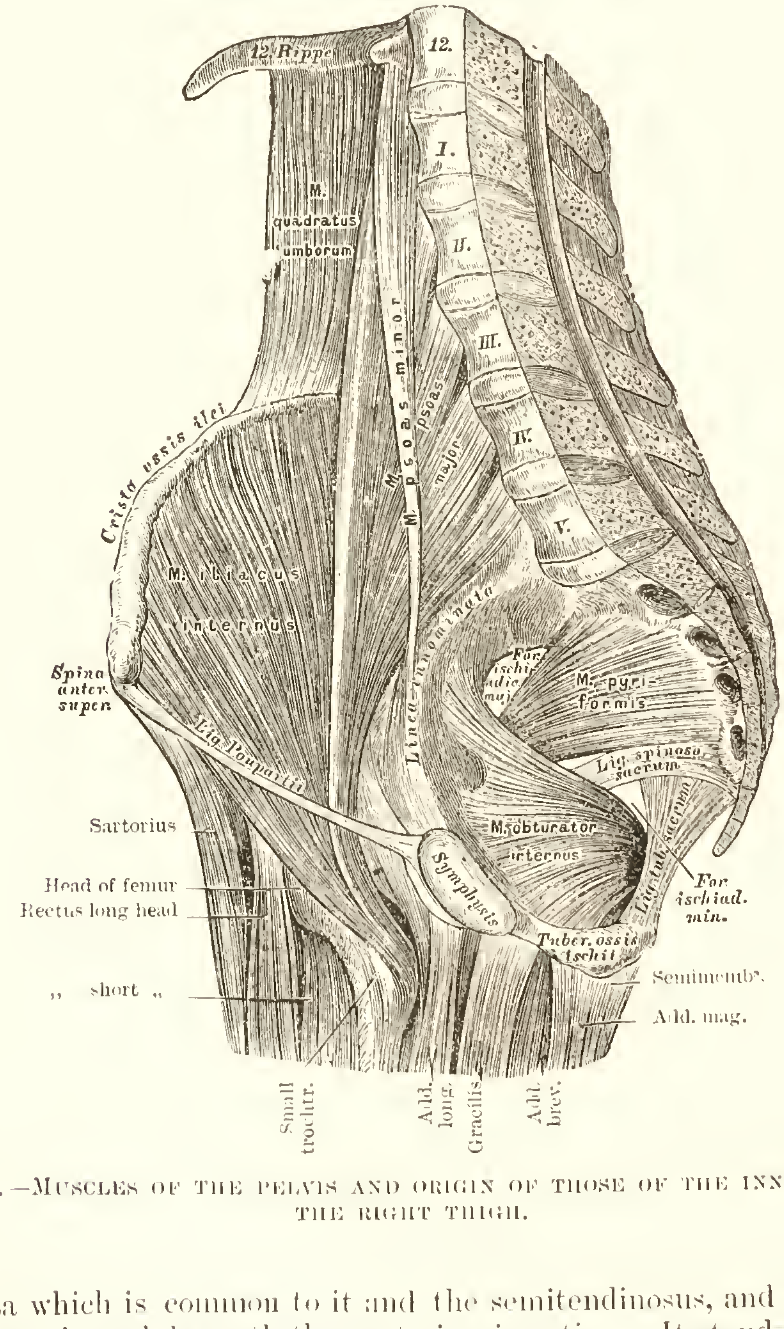


FIG. 284.—MUSCLES OF THE PELVIS AND ORIGIN OF THOSE OF THE INNER SIDE OF THE RIGHT THIGH.

vial bursa which is common to it and the semitendinosus, and which projects above it and beneath the sartorius insertion. Its tendon sends an expansion to the deep fascia of the leg.

Relations.—Superficially, with the fascia lata and with the sartorius below. The internal saphenous vein crosses obliquely over it near its lower part being superficial to the fascia lata. *Deeply*, with the adductors,

semi-membranosus and internal lateral ligament, from which it is separated by a bursa, and it forms part of the inner boundary of the popliteal space.

Action.—It flexes the knee, rotates the tibia out, and assists the sartorius in flexing the leg and drawing it inwards. It is also an adductor of the thigh. Acting from below, it will assist in maintaining the pelvis on the femur.

Nerve.—The obturator.

The **Pectineus** is the highest of these muscles, and is placed at the anterior, upper, and inner aspects of the thigh passing from the pelvis to the inner side of the femur. It is flat and quadrangular, and *arises* from

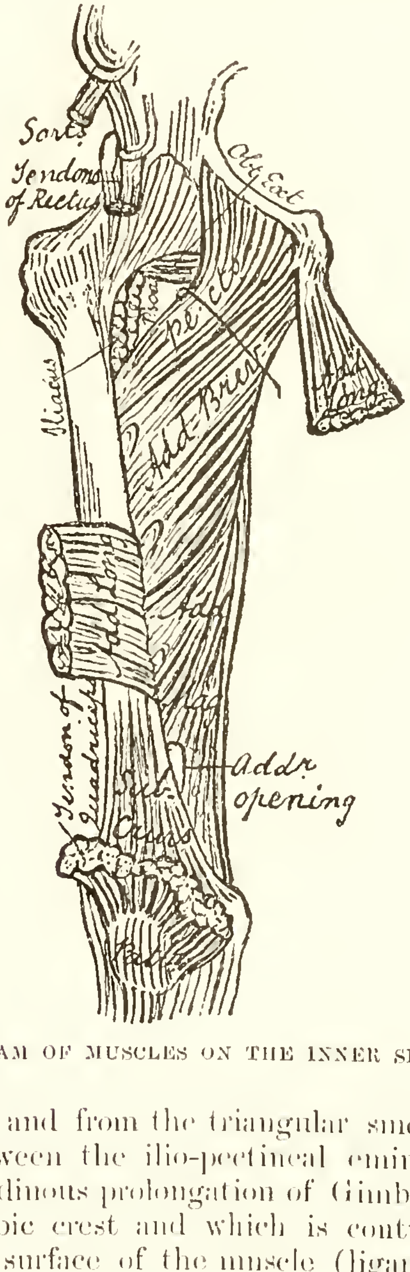


Fig. 285.—Diagram of muscles on the inner side of the thigh.

the ilio-pectineal line, and from the triangular smooth surface of bone in front of that line between the ilio-pectineal eminence and spine of the pubes, also from a tendinous prolongation of Gimbernat's ligament, which is attached to the pubic crest and which is continuous with the fascia covering the anterior surface of the muscle (ligament of Cooper). The fibres pass down, back, and out, to be *inserted* by a flat tendon, about two inches wide, into the femur behind the small trochanter, and into the upper part of the rough line which leads from the trochanter minor to the

linea aspera. This muscle is twisted so that the surfaces which are directed forwards and backwards near the pelvis are, at the femur, turned in and outwards.

Relations.—*Anteriorly*, with the pubic part of the fascia lata, which separates it from the femoral vessels, the deep external pudic artery, and the internal saphenous vein. *Posteriorly*, with the anterior branches of the obturator vessels and nerve, the obturator externus and abductor brevis muscles, and with the hip-capsule. Its *inner border* is in relation with the adductor longus, and its *outer* is separated from the psoas by a slight cellular interval along which runs the femoral artery.

Varieties.—It is frequently divided into two portions which are separated above, and have their nerves from different sources, the outer part being supplied from the anterior crural and the inner by the obturator nerve. This dual separation is normal among animals. It has been seen attached to the capsule of the hip or even inserted into it.

Action.—It adducts the femur and flexes the hip-joint, further, because of its oblique direction and twisted arrangement it can rotate the thigh outwards. Acting from the femur, it supports the pelvis, or can draw it forwards in stooping.

Nerve.—Branches from the lumbar plexus.

The **Adductor Longus** is the most superficial of the three adductors and is a flat triangular muscle, internal to, but on the same plane, as the pectineus, with which it is often blended. It *arises* by a short, flat, narrow tendon from the front of the body of the pubes at the angle of junction of the crest and the symphysis, and expands into a broad fleshy belly which passes down, back, and out, to be *inserted* by an aponeurosis into the middle third, or into nearly the whole of the inner margin of the linea aspera, between the adductor magnus and the vastus internus. Aponeurotic bands connect its tendon of insertion with the adductor magnus and vastus internus, helping to form Hunter's canal.

Relations.—*Anteriorly*, with the sartorius, fascia lata, and near its insertion with the femoral vessels. *Posteriorly*, with the adductor brevis and magnus, the anterior branches of the obturator vessels and nerves, and near its insertion with the profunda artery and vein. Its *outer border* is close to the pectineus and its *inner border* to the gracilis. It forms the inner boundary of Scarpa's triangle.

Varieties.—It may be divided into two muscular bundles, or it may extend as far as the knee, its tendon being inseparably united with that of the adductor magnus.

Action.—It adducts the femur, assisting the other adductors, and it can flex the hip-joint. It aids the other adductors in drawing forwards the leg in walking or running, and in grasping the sides of the horse in riding. Taking its fixed point at the femur, it helps to prop the pelvis on the femoral head and also flexes it on the thigh.

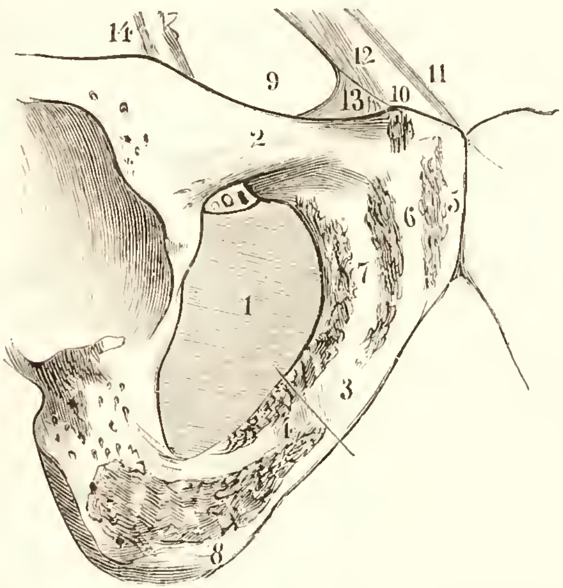
Nerve.—The obturator.

Dissection.—To expose the branches of the obturator artery and nerve, also the adductor brevis muscle and the profunda artery and vein with their branches, the pectineus and adductor longus must be divided near their origins and carefully reflected, so as not to injure the small accessory obturator nerve which turns beneath the outer border of the former muscle, and so as not to destroy the branches of the obturator nerve be-

neath the adductor longus, the tendon of which is to be carefully separated from that of the adductor magnus beneath it, in order that the branches of the deep femoral artery may be exposed.

If these directions be followed, the adductor brevis will come into view, and on it will be found a branch of the obturator nerve to the femoral artery; also an offset to the femoral plexus. The adductor brevis should be separated from the magnus, and the lower branch of the obturator nerve and artery will be seen to issue between them. Near this point a slender branch of the obturator nerve to the knee joint will be found descending on, or in, the fibres of the adductor magnus. The deep part of the obturator nerve will be subsequently seen beneath the adductor brevis.

The *Accessory Obturator Nerve*, when present, arises from the obturator near its upper end, or separately, from the third and fourth lumbar nerves. It descends along the inner border of the psoas over the pubes to beneath the pectineus, where it divides into several branches, one of which joins the anterior or superficial branch of the obturator nerve. Another pierces



1. Obturator membrane.
2. Attachment of pectineus, and beneath it the obt. art. and nerve.
3. Ramus of pubes.
4. Ramus of ischium.
5. Gracilis.
6. Add. brevis.
7. Obt. ext.
8. Add. mag. and tuber ischii.
9. Deep femoral ring.
10. Ext. abd. ring.
11. Int. pillar of ring.
12. Ext. pillar of ring.
13. Gimbernat's ligt.
14. Ilio-pectineal band separating the ilio-psoas from the vessels.

FIG. 286.—EXTERNAL VIEW OF RIGHT SIDE OF PELVIS WITH MUSCULAR ATTACHMENTS.

the pectineus on its under surface, and a third accompanies the articular artery to the hip-joint.

Varieties.—It is often absent. Schmidt, its discoverer, found it only four or five times in nine or ten bodies. When present it may be smaller than usual, and may end in the hip joint; and when it is absent the hip receives compensating branches from the obturator nerves.

The **Adductor Brevis** is placed immediately behind the pectineus and adductor longus, and is thick above and broad below. It is triangular, and *arises* by an origin partly fleshy, and in part aponeurotic, which is two inches in depth, from the outer surface of the body and descending ramus of the pubes, between the gracilis and obturator externus. It passes down, out, and back, and is *inserted* by a flat tendon or aponeurosis into the whole of the oblique line leading from the linea aspera to the small trochanter, immediately behind the pectineus and upper part of the adductor longus.

Varieties.—It is frequently divided into two or three parts, and it may be incorporated with the magnus.

Relations.—*Anteriorly*, are the pectineus, adductor longus, anterior branches of the obturator vessels and nerve, and the profunda vessels; *posteriorly*, with the adductor magnus, posterior branches of the obturator vessels and nerve, and a branch of the internal circumflex artery. Its *outer and upper borders* are in relation with the obturator externus, the conjoined tendon of the psoas and iliacus, and the internal circumflex artery

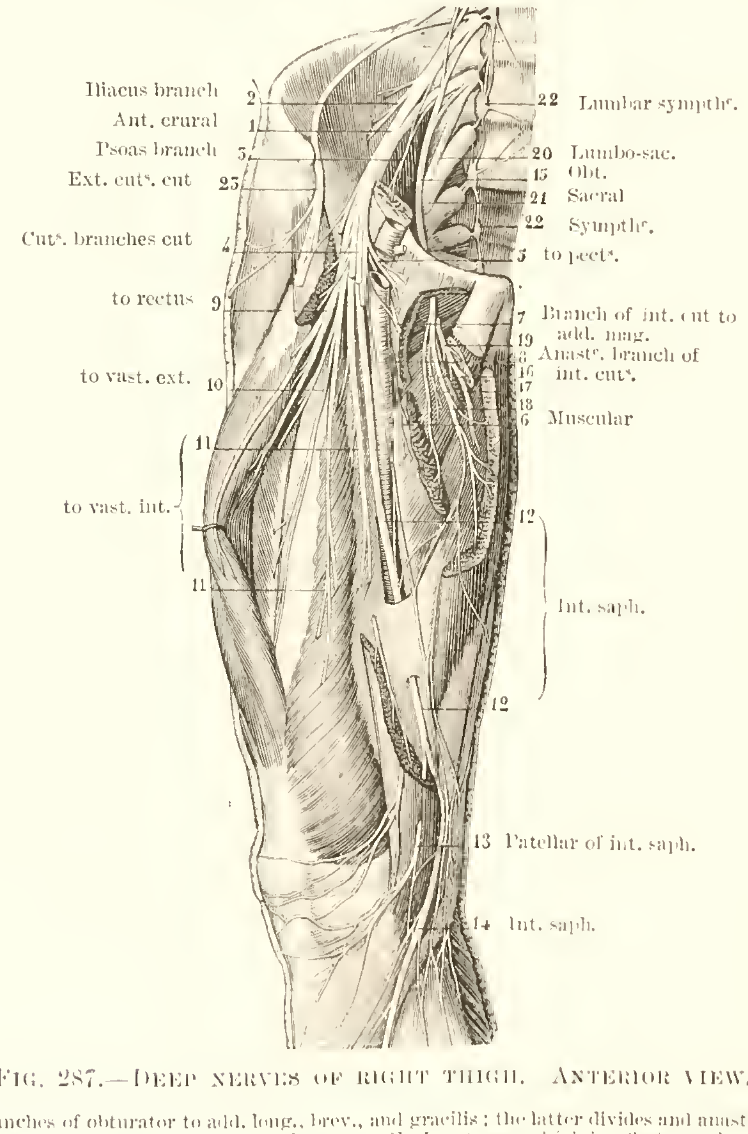


FIG. 287.—DEEP NERVES OF RIGHT THIGH. ANTERIOR VIEW.

16, 17, 18, 19. Branches of obturator to add. long., brev., and gracilis; the latter divides and anastomoses with int. saph. and the deep branch of int. cut. 21. Lumbo-sacral joining first sacral.

passes between it and the obturator externus. *Its inner and lower borders* with the gracilis and adductor magnus. It is pierced near its insertion by the middle perforating branch of the profunda artery.

Action.—It adducts the femur, and flexes the hip, and acting from below, will draw the pelvis forwards and assist the upper fibres of the magnus and the longus in rotating the pelvis to its own side.

Nerve.—The obturator.

The **Obturator Nerve** comes by two roots from the anterior primary

branches of the third and fourth lumbar nerves, and leaves the pelvis above the obturator vessels, through the upper part of the obturator or thyroid foramen, through which it passes into the thigh, and at once divides into an *anterior or superficial* and *posterior or deep branch*, which are separated from each other by the adductor brevis. It supplies the adductors, the obturator externus, the hip and knee joints, and sometimes the skin of the inner part of the thigh and leg.

The *anterior or superficial* part of the nerve descends in front of the adductor brevis, and beneath the pectineus and adductor longus to the lower border of the latter, where it communicates with the inner branch of the internal cutaneous, and with the internal saphenous nerves in the femoral plexus. It then is distributed along the femoral artery.

Branches.—A *communicating* branch which joins the accessory obturator nerve.

An *articular* branch is given off near the obturator foramen, which accompanies an artery to the hip joint.

Muscular branches to the gracilis, adductor magnus, and sometimes to the adductor brevis, and pectineus. These and the communicating branch are given off beneath the pectineus.

The termination of the nerve turns outwards upon the femoral artery, and breaks up into filaments that surround the vessel.

Varieties.—In some subjects the communicating branch is larger than usual, and emerges from the lower border of the adductor longus, and descends along the posterior margin of the sartorius to the inner side of the knee, where it pierces the deep fascia, joins the long saphenous nerve, and passes down to supply the skin of the inner side of the leg, as low as its middle. When this branch is small, its place is taken by an inner branch of the internal cutaneous nerve, and *vice versâ*; when this nerve is present, the branch of the internal cutaneous of the anterior crural is small, the size of the two nerves bearing an inverse proportion to each other. When large, it sends branches to the femoral plexus.

The *Posterior or Deep Branch* of the obturator nerve perforates the obturator externus, and passes behind the adductor brevis to the front of the adductor magnus, where it divides into many *muscular branches*, which supply the obturator externus, the adductor magnus, and occasionally the adductor brevis, i.e. if this muscle receives no branch from the anterior division of the nerve.

The *Articular* branch for the knee is long and slender, and rests at first on the adductor magnus, but pierces its lower fibres to reach the upper part of the popliteal space. It then descends upon the popliteal artery to the back of the knee, and after sending filaments around, the vessel enters the joint through the posterior ligament.

Directions.—The veins and the fatty tissue must be removed from the perforating branches of the profunda, and the internal circumflex should be traced to its origin, above the upper border of the adductor brevis.

The **Profunda Femoris, or Deep Femoral Artery,** nearly equals the superficial femoral in size, and is given off from the outer and back part of the common femoral, about an inch and a half to two inches below Poupart's ligament. It is the principal nutrient vessel of the muscles and soft parts of the thigh. At its commencement it passes out in front of the iliacus, and then runs down and back behind the femoral vessels to the inner side

of the femur, passing between the femoral attachments of the adductors longus and magnus, and at the lower third of the thigh ends in a branch which pierces the adductor magnus, to be distributed to the muscles on the back, and outer part of the thigh, anastomosing with branches of the popliteal and inferior perforating arteries. On the inner side of the femur it is parallel to the superficial femoral artery, though deeper than it.

Relations.—Behind it are the iliacus, pectineus, adductor magnus and brevis muscles. *In front*, it is separated from the femoral artery by the femoral and profunda veins; and below, by the adductor longus. On its *outer side* is the origin of the vastus internus, and on its *inner side* is the superficial femoral artery.

Relations of the Profunda Artery.

In front.—The femoral and profunda veins and the adductor longus.

Outside.—Origin of the vastus internus.

Profunda Artery

Inside.—The superficial femoral artery.

Behind.—The pectineus, iliacus, and adductors brevis and magnus.

Branches.—Its branches (*muscular*) to the muscles on the front and back of the thigh are numerous, and anastomose freely with other vessels of the thigh, leg, and pelvis. Of course, by these free communications, the blood is brought to the lower part of the limb when the passage of the main vessel is obstructed, either by disease or by a ligature. The named branches of the profunda are, the *external circumflex*, *internal circumflex, and perforating.* The first has already been described.

The **Internal Circumflex Artery** is smaller than the external, and arises close to that branch from the inner and hinder part of the profunda, and passes backwards around the inner side of the femur, between the pectineus and psoas muscles, but above the adductors brevis and magnus. Opposite the small trochanter, and near the tendon of the obturator externus, along which the artery passes to the back of the thigh, it divides into two principal branches, *ascending and transverse.*

The *Ascending Branch* is distributed to the adductors, gracilis, and partly to the obturator externus, anastomosing with the obturator artery. Another larger muscular twig descends with the deep piece of the obturator nerve beneath the adductor brevis, supplying it and the magnus, while the continuation of the internal circumflex passes back as the *transverse* branch, above the small trochanter, between the quadratus femoris and upper border of the adductor magnus, to the back of the limb, where it supplies the hamstring muscles and anastomoses with the sciatic, superior perforating, and external circumflex arteries.

An *Articular* vessel is given off from the *transverse* branch opposite the hip joint, which it enters through the acetabular notch beneath the transverse ligament, and after supplying the fatty tissue and synovial membrane, passes along the round ligament to the head of the femur.

Sometimes the articular branch comes from the obturator artery, and sometimes there are branches from both sources.

Varieties.—The internal circumflex may arise from the common femoral or external iliac, and, more rarely, from the epigastric or external circumflex branches of the external iliac.

The *Perforating Arteries* are three or four in number, and reach the

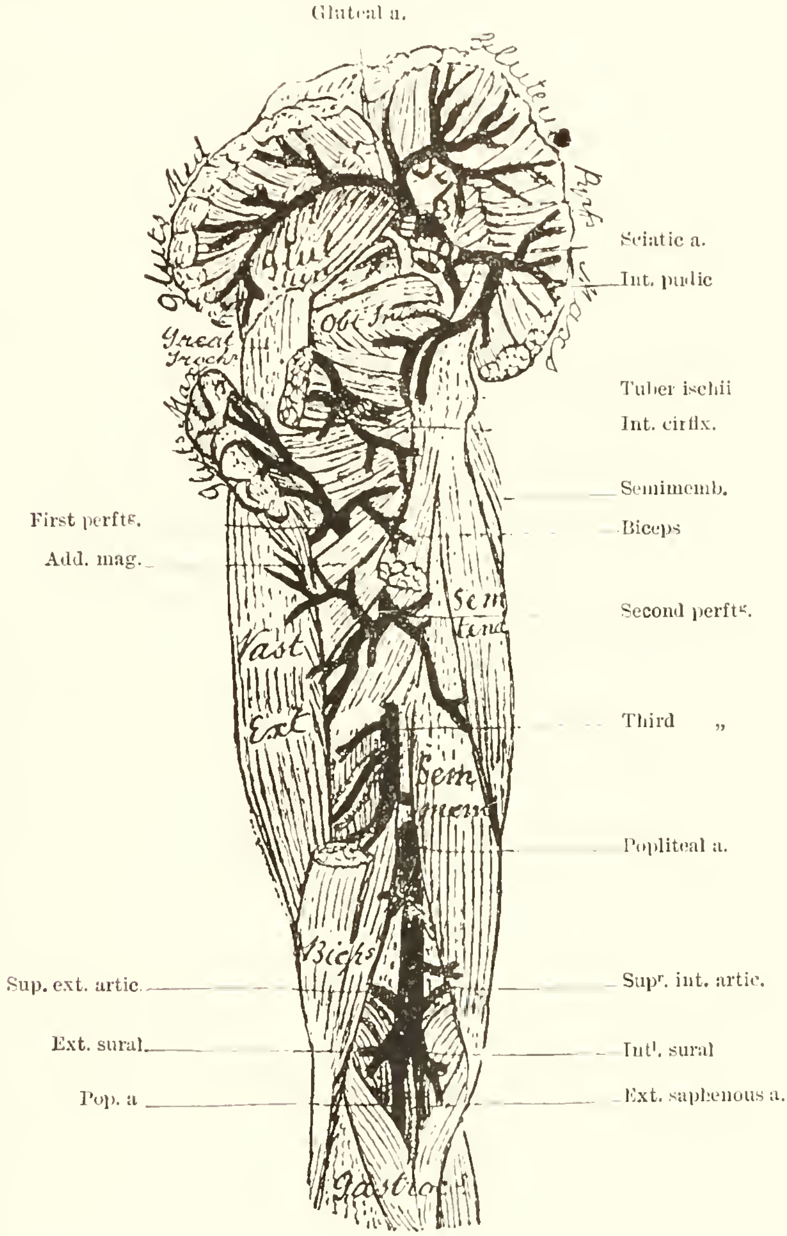


FIG. 288.

back of the thigh, by piercing the tendons of the adductors brevis and magnus, close to the linea aspera.

The *First Perforating* is given off above the adductor brevis, and pierces the adductors brevis and magnus, supplying both these, the biceps, and gluteus maximus, and anastomosing with the sciatic, internal circumflex, and middle perforating.

The *Second or Middle Perforating* branch is much larger than the

first, arises opposite the middle of the adductor brevis, pierces the tendons of the adductors brevis and magnus, and divides into ascending and descending branches, which ramify in the hamstring muscles, the *ascending* twigs anastomosing with the superior perforating, and the *descending* with the inferior perforating arteries. It gives off the nutrient artery of the femur, which in the substance of the bone runs up towards the hip.

The *Third or Inferior Perforating* artery is given off below the adductor brevis, and pierces the adductor magnus below the insertion of the adductor longus, to divide into branches which supply the flexor muscles of the leg, anastomosing with the descending branches of the middle perforating, and with the termination of the profunda or fourth perforating artery.

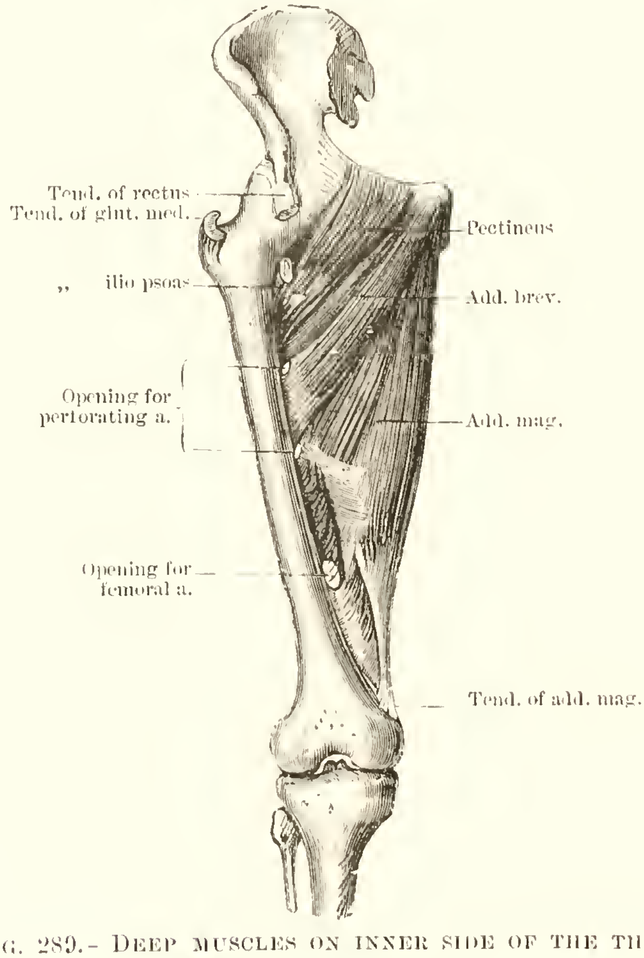


FIG. 289.—DEEP MUSCLES ON INNER SIDE OF THE THIGH.

The adductor longus is removed.

The *Fourth Perforating vessel* or *Terminal Branch of the Profunda* passes back close to the linea aspera, piercing the adductor magnus near the opening for the femoral artery. It supplies the short head of the biceps, and the other hamstrings, and inosculates with the third perforating and upper inner articular branch of the popliteal.

There are three or four *muscular* or *anastomotic* branches which pierce the adductor magnus at some distance from the linea aspera, and anastomose among themselves and with the perforating arteries, in the hamstring muscles.

The **Profunda Vein** is formed by the union of branches corresponding with the offsets of the profunda artery. It closely accompanies the artery lying superficial to it, and ends in the femoral vein about an inch and a half below Poupart's ligament.

Dissection.—Cut through the adductor brevis near its origin and reflect it, and remove the fat and fascia from the obturator externus, adductor magnus, and psoas and iliacus muscles, which will be exposed. After learning the adductor magnus, some of its upper fibres may be removed so as thoroughly to examine the attachments of the obturator externus.

The **Adductor Magnus** is a large triangular muscle which forms a fleshy septum between the muscles on the inner and those on the back of the thigh. Its base is at the femur and its apex at the pelvis. Its upper and inner borders are free and it *arises* from the lower part of the pubic body, from the rami of pubes and ischium, and from the outer margin and under surface of the ischial tuberosity. The fibres diverge from their origin like the ribs of a fan, those which arise from the pubic ramus are shorter than the rest, pass horizontally outwards and are *inserted* into the lower part of the linea quadrati, and into the rough line prolonged from the linea aspera to the great trochanter, internal to the gluteus maximus; those fibres which arise from the ramus of the ischium pass with increasing obliquity down and out to be *inserted* by a broad aponeurosis into the whole length of the linea aspera, and into the upper part of its inner bifurcation. These two portions constitute the *anterior* part of the muscle. The *posterior* or *internal portion* of the muscle consists mainly of the fibres which arise from the ischial tuberosity and which descend almost vertically, forming the inner border of the muscle, and end in a narrow rounded tendon, which is *inserted* into the tubercle above the inner condyle of the femur, being connected by a fibrous expansion to the line leading from the linea aspera to the femoral tubercle. Between the two portions of the muscle there is an angular interval which is tendinous in front and fleshy behind, and is for the passage of the femoral vessels into the popliteal space. This interval is situated below the level of the inner condyloid ridge of the linea aspera, between the tendinous and fleshy insertions of the muscle. The *outer* or *anterior* portion of the muscle is interrupted along its femoral attachment by three or more tendinous arches through which perforating arteries pass. This muscle gives off an aponeurosis which consists of transverse fibres passing from the surface of the vastus internus to the adductors magnus and longus. It is thinner at its upper part and encloses a three-sided passage which was described by Hunter and is called *Hunter's canal.* He was the first to ligature the superficial femoral in this situation.

Relations.—*Anteriorly*, with the pectineous, adductors brevis and longus, vastus internus, femoral vessels, profunda artery, and obturator nerve. *Behind*, with the great sciatic nerve, the hamstring muscles, and the gluteus maximus. *Internally*, with the gracilis, sartorius, and fascia lata. *Externally*, it is attached to the femur behind the adductors brevis and longus which separate it from the inner vastus, and is in front of the gluteus maximus and short head of the biceps, which separate it from the outer vastus. It is pierced by the femoral and perforating arteries, and by the branch of the obturator nerves to the knee joint. Its *upper border*

is in relation with the obturator externus and quadratus femoris muscles and internal circumflex vessels.

Action.—It is a powerful adductor of the thigh, and projects the femur forwards in walking or running. The glutei muscles, which are the opponents of the adductors, assist them in walking. Acting from below, it is a powerful factor in maintaining the pelvis erect on the femur, and will also help in bringing the pelvis forwards.

Varieties.—It varies in the degree of its segmentation. The upper transverse part is so often separated from the rest by the profunda artery, that some anatomists have described it as a special muscle called the *Adductor minimus*. Its condylar portion has been seen to be quite distinct from the rest of the muscle, but on the other hand the muscle has been found undivided, and its upper part completely united to the quadratus femoris. I perfectly recollect one well-marked instance of this arrangement.

Nerves.—The obturator and great sciatic.

The **Psoas** and **Iliacus**, or Ilio-Psoas, have separate origins from the lumbar vertebræ and innominate bone, but are joined in the thigh. The conjoined part of these muscles passes beneath Poupart's ligament, and the tendon of the psoas is inserted into the small trochanter. Its tendon, which is at first within the substance of the muscle, is afterwards at its outer side where it receives the fibres of the iliacus. The fleshy iliacus is partly inserted with the tendon of the psoas, and partly by fleshy fibres into a special triangular impression on the upper part of the femur in front of, and below, the lesser trochanter.

Variety.—There is sometimes a small detached piece of the iliacus called the *ilio-capsularis*, or *iliacus minor*; it arises from the anterior inferior spinous process of the ilium and is inserted into the anterior inter-trochanteric line, and is closely united to the front of the hip capsule.

Relations.—Beneath Poupart's ligament the muscles fill the interval between the anterior superior iliac spine and the ileo-pectineal eminence. In *front* of the iliacus is the anterior crural nerve, and *behind* it is the hip capsule and a small bursa. At its *outer border* are the origins of the rectus and sartorius, and at its *inner edge* is the psoas.

In *front* of the psoas is the femoral artery, *behind* it is a large bursa separating it from the hip capsule. This bursa sometimes communicates with the joint. At its *outer margin* are the rectus, vastus internus, sartorius and anterior crural nerve, and its *inner margin* is separated from the pectineus by the internal circumflex vessels.

Action.—These muscles flex the hip joint and rotate the femur outwards; their further use will be given with the dissection of the abdomen.

The **Obturator Externus** is a flat triangular muscle which covers the outer surface of the anterior pelvic wall. Its apex is at the femur, and its base at the pelvis. It *arises* from the outer surface of the anterior two-thirds of the obturator membrane, from the outer surface of the body and ramus of the ischium, and also from a tendinous arch which completes the canal for the passage of the obturator vessels and nerves. Its fibres converge to a tendon which passes horizontally out and back along the groove between the acetabulum and tuber ischii, in contact with the under and

hinder surfaces of the femoral neck, to be *inserted* into the digital or trochanteric fossa below the obturator internus and gemelli.

Relations.—Anteriorly, with the pectineus, ilio-psoas, gracilis, and adductors brevis and magnus, and more externally with the capsule covering the back of the hip joint. *Posteriorly*, with the obturator membrane, quadratus femoris, and deep part of the obturator nerve which pierces it. The obturator vessels and nerves pass over its upper border, and its tendon is in contact with the lower and posterior parts of the hip capsule while it is in the groove beneath the acetabulum.

Action.—It is an external rotator of the thigh, and also a flexor and adductor, as when we sit with the knees crossed; it also supports the hip joint below and behind.

Nerve.—The obturator.

Dissection.—Carefully remove some of the fibres of the obturator externus, to bring into view the branches of the obturator artery and nerve; or this dissection may be left until after the limb has been removed.

The **Obturator Artery** is usually a branch of the anterior division of the

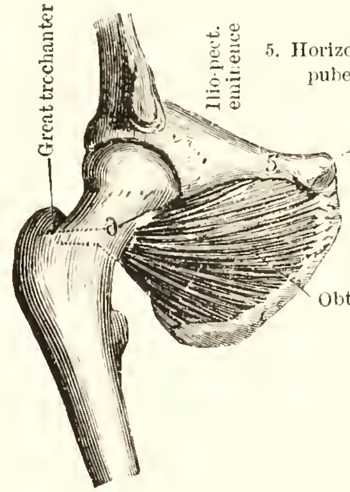


FIG. 290.—RIGHT OBTURATOR EXTERNUS AND ITS TENDON PASSING BEHIND THE NECK OF FEMUR.

internal iliac, and passes along the side of the pelvis to reach the groove at the upper part of the thyroid foramen, where it divides into two branches which encircle the obturator membrane beneath the muscle. Beneath the pubes it lies in an oblique canal with its accompanying vein and nerve. This canal is formed partly by a groove in the bone, and partly by fibrous tissue. Its two terminal branches are *external or lower* and *internal or upper.*

The *External branch* curves around the outer margin of the thyroid foramen, supplies the obturator muscles and the upper attachments of the hamstrings, gives off small branches to the hip, and passes along the round ligament to the head of the femur, supplying it and the synovial fatty tissue.

It anastomoses with the internal branch, with the upper branch of the internal circumflex, and near the tuber ischii with the sciatic.

The *Internal branch* has a similar arrangement near the inner margin

of the foramen, and after piercing the membrane forms a circle by joining the upper branch. It gives branches to the obturators, adductors, and gracilis. It communicates with the external branch near the lower border of the obturator membrane.

The *varieties* of the obturator artery have been given with the dissection of femoral hernia.

FIG. 291.—RIGHT OBTURATOR AND INTERNAL PUDIC ARTERIES AND OBTURATOR INTERNUS AND LEVATOR ANI MUSCLES, SEEN FROM THE INSIDE.

The *deep part of the Obturator nerve* gives branches to the obturator externus; these perforate the membrane with the lower branch of the artery.

Directions.—After rehearsing the contents of this paragraph and thoroughly testing his knowledge on the body, the student will, when the body is turned, proceed with the dissection of the gluteal region.

THE GLUTEAL REGION.

Directions.—The body being on its face, the pelvis is to be raised on blocks and the lower limbs allowed to hang over the end of the table. The buttock and the back of the thigh must be dissected before the body is again turned.

Surface Markings.—The bony parts to be observed are the crest of the ilium, the sacrum, and the coccyx in the mid-line. The posterior superior spine of the ilium will be observed to be on a level with the second sacral spine. At the third sacral spine the cauda equina ends.

The sacro-iliac synchondrosis extends between the first and third sacral spines. The dissector should feel the depression between the last rib and the iliac crest, and should measure the distance between the anterior and the posterior superior spinous processes of the ilium, because half an inch posterior to the half-distance between these points is the spot which corresponds with the *outer* border of the quadratus lumborum. An oblique incision midway between the last rib and crest of the ilium, the centre of which corresponds to the outer border of the quadratus lumborum, is the best one to adopt in the operation for opening the descending colon in left lumbar colotomy. This portion of large intestine is usually devoid of peritoneum on its posterior aspect, and is frequently opened in obstructions of the rectum.

The other bony points are the tuber ischii, and the great trochanter of the femur. Stretching between the sacrum and the tuber ischii beneath the gluteus maximus the student may feel the great sacro-sciatic ligament by passing his finger upwards beneath the lower border of the muscle. His finger will sink into the ischio-rectal fossa. Between the tuber ischii and the great trochanter run the greater and lesser sciatic nerves, and the

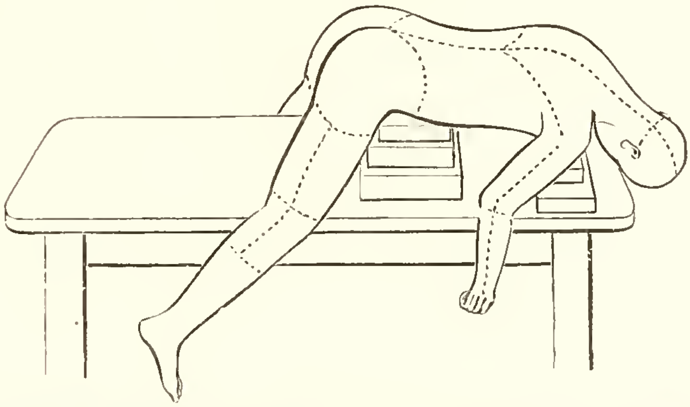


FIG. 292.—DIAGRAM OF POSITION OF BODY AND INCISIONS FOR DISSECTING THE BACK OF THE BODY.

sciatic artery. The nerves are a little nearer the tuber than the great trochanter.

The *Trochanter major* is an important surgical landmark, and the surgeon has frequent opportunity to examine its relations, in cases of fracture, dislocation, or disease of the hip joint or its neighbourhood. A line passing from the anterior superior spinous process of the ilium to the middle of the tuber ischii is, in most subjects, on a level with the upper margin of the great trochanter. This line also runs over the centre of the acetabulum. In fractures of the neck of the femur, or when the head of the bone is completely, or even partially displaced from the acetabulum, the upper part of the great trochanter will either be above or below this line according to the nature of the injury or disease. The gluteal fold which is formed by the lower margin of the gluteus maximus, and the subcutaneous fat, is also a beacon which will assist the surgeon in diagnosing disease or injury in this region.

Let the student sink his fingers between the tuber ischii and the great trochanter, and also above the great trochanter, and if he now rotate

the femur he will be able to feel the movements of the neck of the bone. The dissector should also note that the upper margin of the trochanter major is nearly on a level with the pubic spine, and about three quarters

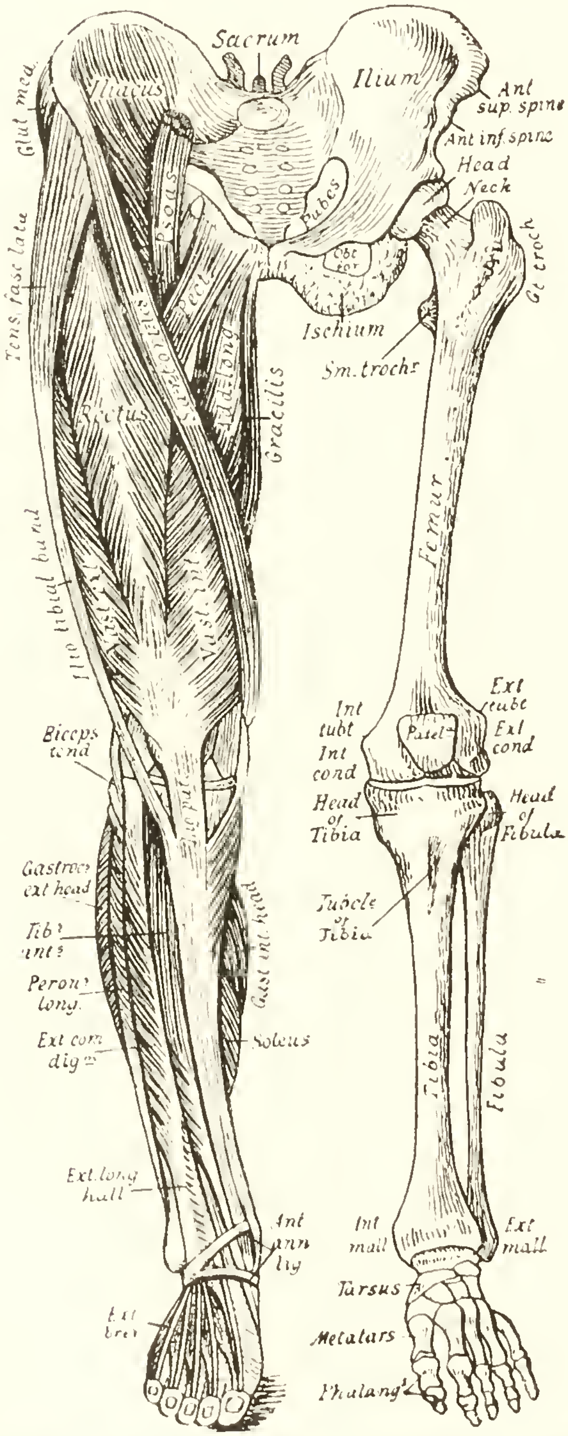


FIG. 293.—BONES AND MUSCLES OF LOWER LIMBS. ANTERIOR VIEW.

of an inch lower than the head of the femur. In doubtful cases of injury or disease the student must compare the position of the great trochanter to the other pelvic bony prominences, and especially should note its rela-

tive position with that of the opposite side supposing the latter to be normal.

The posterior border of the great trochanter is the guide in excision

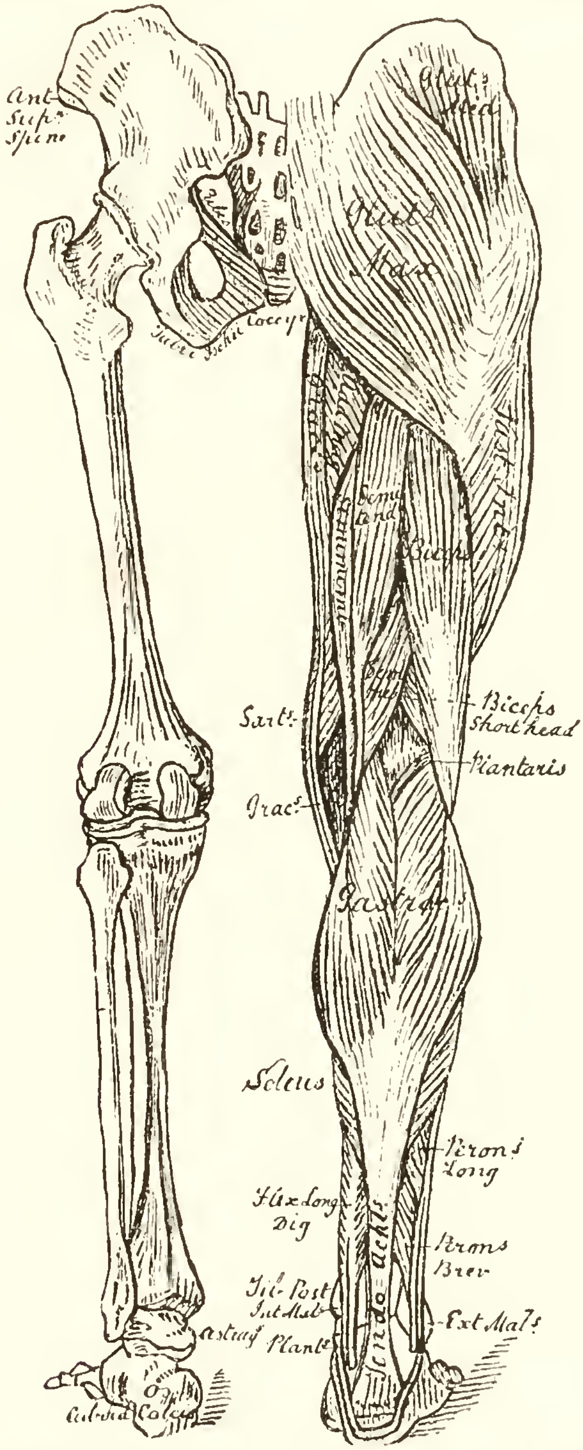


FIG. 294.—BONES AND MUSCLES OF THE BACK OF THE LOWER LIMBS.

The vastus externus is, by mistake, named internus.

of the hip, and its upper border is the spot at which the operation of subcutaneous osteotomy of the neck of the thigh bone is performed. It will

be noted that the shape of this gluteal region is quadrilateral, the superior and inferior borders forming two arcs looking at each other by their concavities. The upper arc is formed by the iliac crest, the lower by the inferior border of the gluteus maximus covered by the skin and fat. The condition of this region with regard to the amount of fat, and with reference to its firmness or flaccidity, varies with the general state of health. Sex also alters the shape of the part. In the male, the buttock is rounder and firmer; in the female, it is larger and more dependent. Racial peculiarity must also be named. Among the Hottentots, when the female arrives at puberty or has had an infant, the subcutaneous fat developes enormously, giving rise to a condition which is regarded as a great sign of

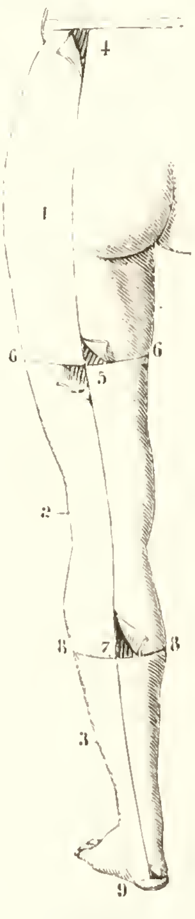


FIG. 295.—DIAGRAM OF INCISIONS IN DISSECTING THE BACK OF THE LOWER LIMB.

Another method which differs from that in the text. Compare with first figure of this section.

beauty. In these Kaffir Venuses this gluteal fold of fat frequently reaches to near the back of the knee.

In the erect position of the body the tubera ischii are covered by the gluteus maximus, and in the sitting posture they support the body weight and are frequently covered by a thick pad of lobulated fat and a bursa. This latter when enlarged or inflamed (which is not uncommonly the case in people who ride much) has been called consequently 'The Rider's Bursa.' The bursa which is found over the great trochanter enlarges frequently in tailors through being exposed to pressure by their sitting on

boards or benches cross-legged, and is therefore called 'The Tailor's Bursa.'

Humiliating though it be, it is an undoubted anatomical fact that the prominence of the nates is characteristic of mankind and is directly associated with the acquisition of the erect position.

The student should draw a line from the posterior superior spine of

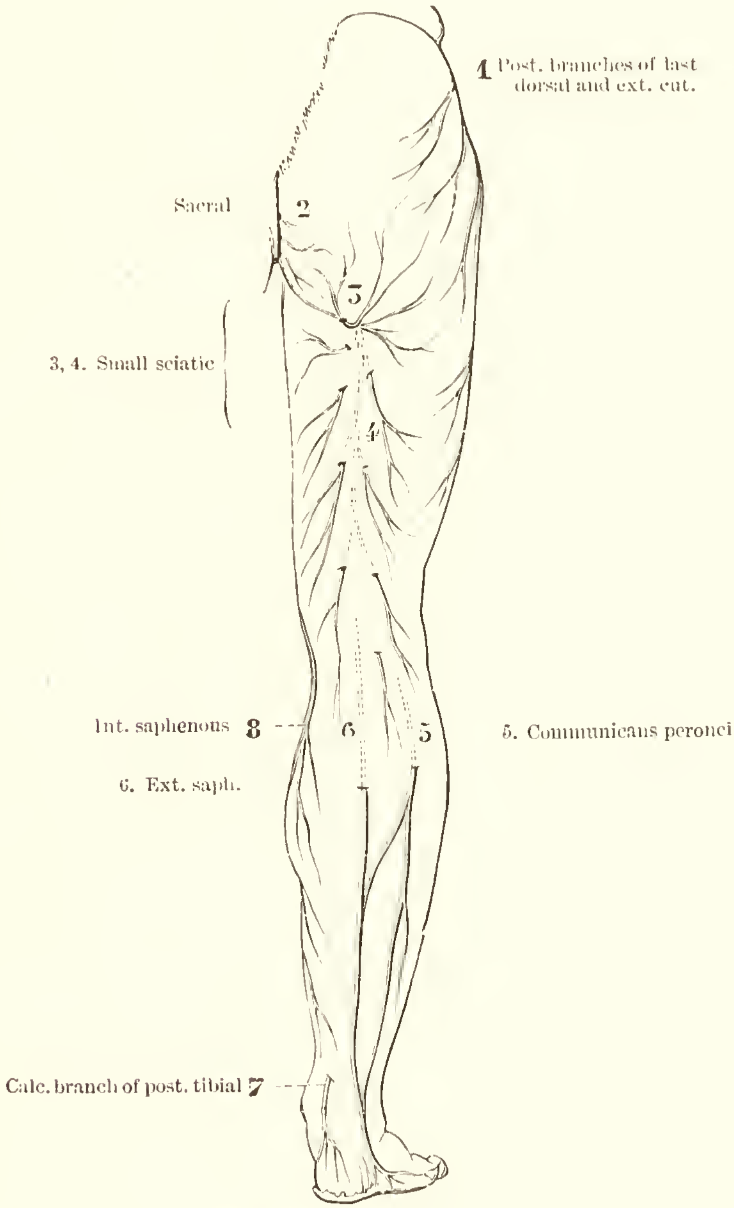
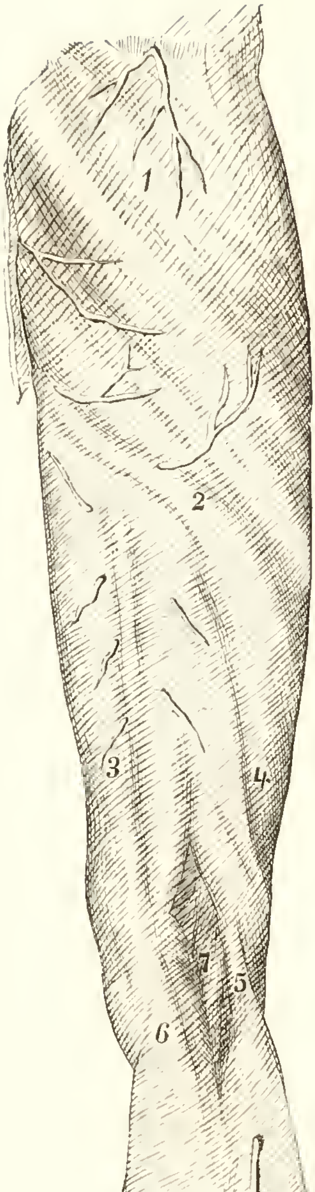


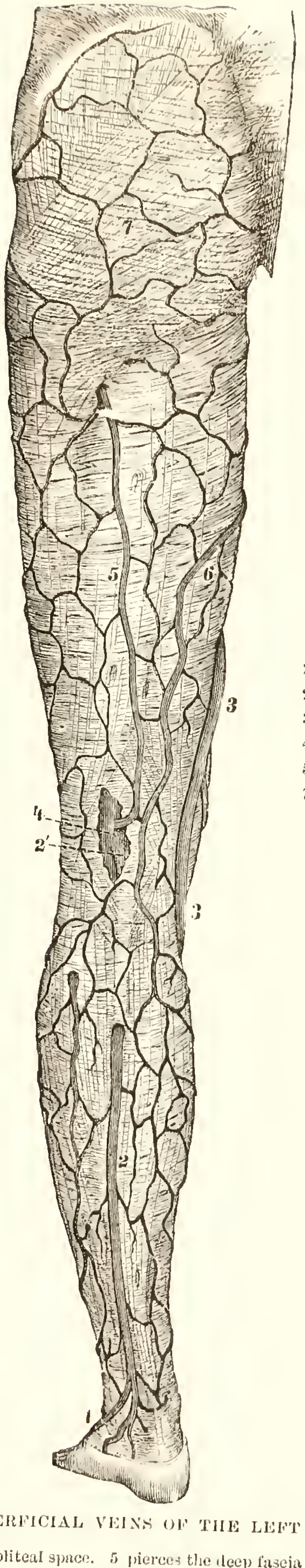
FIG. 296.—SUPERFICIAL NERVES OF THE BACK OF THE RIGHT LOWER LIMB.

the ilium to the upper border of the trochanter major, with the thigh rotated inwards. At the point where the upper meets with the middle third of this line the gluteal artery leaves the pelvis above the pyriformis muscle, through the great sacro-sciatic foramen. The sciatic artery quits the pelvis about half an inch lower than the gluteal. Draw another line from the outer border of the tuber ischii to the posterior superior spine of



1. Gluteal fascia.
2. Fascia lata.
3. Prominence of add. mag.
4. Line of ext. intmuscr. septum.
5 and 6. Prominence of the two heads of gastrocs.
7. Popliteal fascia.
8. Sural fascia.
9. Ext. saph. v.
10. Opening for saph. v. It pierces lower down than usual in this case.

FIG. 297.—CUTANEOUS NERVES AND DEEP FASCIA OF RIGHT LOWER LIMB POSTERIOR VIEW.



1. Ext. dorsal v.
2. ,, saph. v.
2'. Its junction with popl.
3. Int. saph. v.
4. Popltl. v.
5 and 6. Postr. feml. cut^s.
7. Gluteal cut^s.

FIG. 298.—SUPERFICIAL VEINS OF THE LEFT LOWER LIMB.

An aperture has been made in the popliteal space. 5 pierces the deep fascia to join the gluteal, and 6 joins the intl. saphena vein.

the ilium. The pudic artery will lie beneath the spot at which the middle joins the lower third of this line. It then passes over the spine of the ischium (where it may be compressed in case of need) into the lesser sacro-sciatic foramen.

From the respective positions of the vessels and nerves it will be observed, that when sitting upright the nerves are not liable to pressure, but become pressed upon when we sit sideways. When seated on firm and even seats the bones sustain the pressure, but when resting on soft supports the pressure reaches the blood-vessels through the soft structures and hampers the arterial flow down to the limbs and the venous reflux into the pelvis, and thus predisposes to piles, and uterine disorders in the female.

Directions.—Make an incision along the iliac crest, continuing along the middle of the sacrum to the end of the coccyx. From this point make another, following the gluteal fold down and outwards to six inches below the great trochanter. Reflect the skin, and note that it is coarse and thick, being much exposed to pressure and friction. Seek the cutaneous vessels and nerves which will be found along the iliac crest and at the sides of the sacrum and coccyx.

Cutaneous Nerves.—Piercing the deep fascia, near the iliac crest and over the aponeurosis covering the gluteus medius, will be found, most anteriorly, offsets of the lumbar nerves, posteriorly branches from the last dorsal, and between the two, the iliac branch of the ilio-hypogastric nerve, and curving backwards below the anterior iliac spine and the great trochanter, will be found the posterior branches of the external cutaneous nerve, if these have not been removed in the dissection of the front of the thigh. Piercing the origin of the gluteus maximus will be found branches of the sacral nerves. The cutaneous nerves are accompanied by cutaneous arteries which come from the sacral, lumbar, superficial circumflex, iliac, gluteal, and external circumflex arteries ; and also by cutaneous veins. At the outer border of the erector spinæ two or three filaments of the posterior branches of the lumbar nerves will also be seen. In the fat over the lower border of the gluteus maximus the student must find branches from the small sciatic. Some of these curve up over its lower border, and others pass inwards to the perineum (long pudendal), and inner side of the thigh, and some course up and down. These branches of the small sciatic nerve are accompanied by cutaneous branches of the sciatic artery.

Dissection.—The thin fascia covering the gluteus maximus must be removed, and after reflecting the cutaneous vessels and nerves the thigh must be adducted and rotated inwards to render tense the fibres of the muscle. Remove the fat and fascia and clean the muscle either from above, down, or *vice versâ*.

The *Fascia* of the gluteal region is continuous with that enveloping the thigh, and is attached to the posterior margin of the iliac crest, and to the sides of the sacrum and coccyx. It is much thicker over the gluteus medius to which it gives partial origin, and is called the *gluteal aponeurosis*. At the upper border of the gluteus maximus it divides into three thin layers.

The *Superficial Layer* covers the gluteus maximus, and is united to the skin by fibrous tracts, and from its deep surface are given off cellular septa, which subdivide the fibres of the muscle into distinct bundles. The

middle layer passes underneath the gluteus maximus, and joins the superficial at its lower border forming a complete sheath for it. The two layers after meeting are continued outwards to join the fascia lata. At the inner and upper parts it passes to the perineum and is attached to the great sacro-sciatic ligament with the inferior aponeurosis of the levator ani. Towards the middle line it is fixed to the sacrum and coccyx. The *deep Layer* covers the gluteus medius and is attached inferiorly to the great sacro-sciatic ligament.

The **Gluteus Maximus** is the largest muscle of the body, and the most superficial in this region, and extends from the back of the pelvis to the upper part of the femur and fascia lata. It is a broad and thick fleshy mass of a quadrilateral shape, and its structure is coarse, being made up of

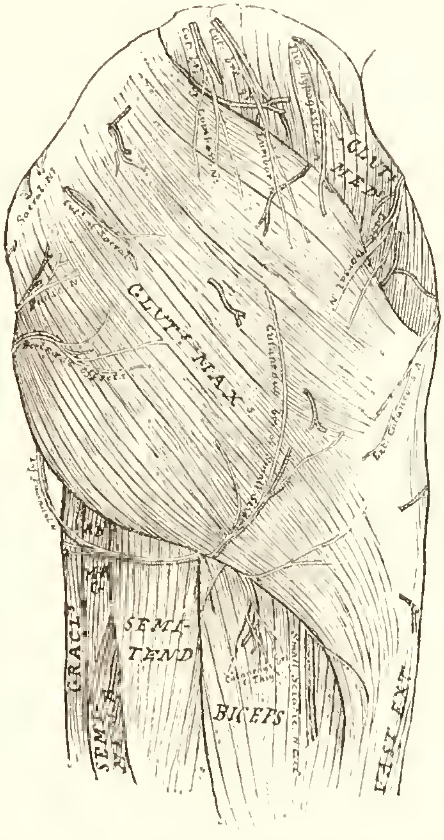


FIG. 299.—SUPERFICIAL DISSECTION OF RIGHT GLUTEAL REGION.

many bundles of separate muscular fasciculi lying parallel with each other. Its origin is partly bony and partly tendinous. It arises from the superior curved line of the ilium, and the posterior third of the iliac crest, and from an impression of the bone below it. From the posterior surface of the last piece of the sacrum, from the side of the coccyx, from the aponeurosis covering the multifidus spinæ, and from the back of the great sacro-sciatic and posterior sacral ligaments. The fibres pass obliquely down and out to be inserted, thus: those forming the larger upper portion of the muscle converge and terminate in a thickish lamina which passes over the great trochanter to be inserted into the fascia lata on the outer side of the thigh. The lower portion of the muscle is inserted for about three inches into the rough line leading from the linea aspera to the great trochanter. This

muscle resembles the deltoid of the arm in forming a prominence protecting the joint also in its coarse texture. There are usually three synovial bursæ beneath it; one of large size and generally multilocular separates it from the great trochanter; another exists between its tendon and the origin of the vastus externus; and a third, which is inconstant, is situated over the tuber ischii.

Relation.—Its *superficial* relations are unimportant and have already been given. Its *deep relations* will be seen on reflecting the muscle and after a little cleaning. They are from above downwards. The posterior surface of the ilium, the sacrum and coccyx. The great sacro-sciatic ligament, a small portion of the lesser ligament, the tuber ischii, and the

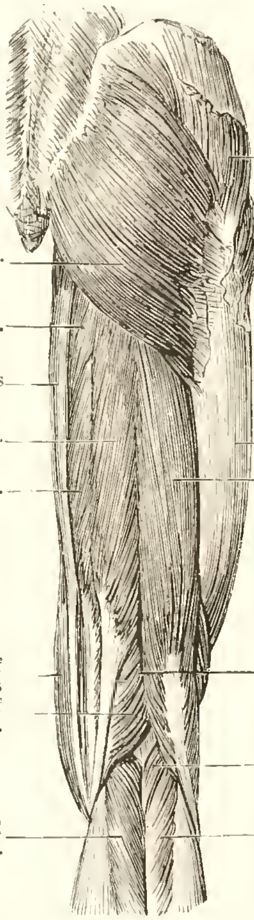


FIG. 300.—POSTERIOR MUSCLES OF THE RIGHT THIGH.

great trochanter. The muscles are the posterior third of the gluteus medius; the pyriformis, gemelli, obturator internus, quadratus femoris, the origins of the biceps, semi-tendinosus, semi-membranosus, and adductor magnus. The vessels are the gluteal artery and vein above the pyriformis, and below it the sciatic and internal pudic vessels and nerves, and nerve to the obturator internus muscle. The superior gluteal nerve accompanies the gluteal artery above the pyriformis. The *upper border* is connected with the gluteus medius; its *lower border* is free, is longer and thicker than the upper, and beneath it the sciatic vessels and nerves and the origins of the hamstring muscles issue.

Actions.—Acting from above it extends the femur and also abducts and rotates it out. It is also a tensor of the fascia lata. Acting from below it fixes the pelvis upon the head of the femur maintaining the erect position. In standing on one leg it can turn the face to the opposite side by drawing the sacrum towards the femur. If the hip joint be bent, as in sitting, it can act as an extensor by moving back the pelvis, and is the chief muscle in raising the trunk from a stooping posture.

Nerves.– It is supplied in its lower two-thirds by the inferior gluteal

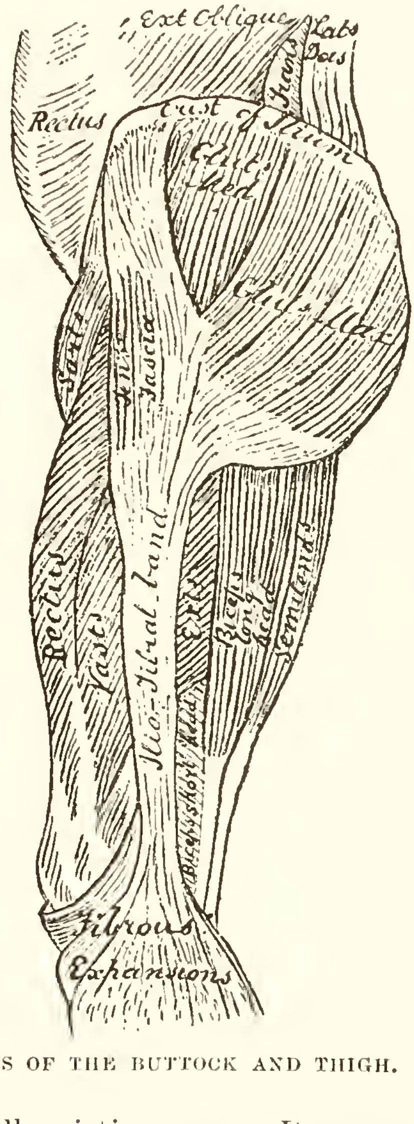


FIG. 301.–MUSCLES OF THE BUTTOCK AND THIGH. EXTERNAL ASPECT.

branches of the small sciatic nerve. Its upper third being supplied directly from the sacral plexus.

Varieties.—It may be partly or entirely bi-laminar. It may be connected with an extra muscle, the *agitator caudæ*, which is attached to the lowest piece of the sacrum, and to the coccyx. It may only be attached to the last two sacral vertebræ, or may have a high fascial slip of origin from the lumbar aponeurosis.

Dissection.—Cut through this muscle near its origin, being careful of the great sacro-sciatic ligament beneath it; note the origin of its lower fibres from this ligament. The vessels and fascia beneath the muscle will

be a guide to its depth. When these are reached the muscles should be thrown downwards; all vessels and nerves entering it being divided. Clean away the fat and connective tissue between the pelvis and the trochanter, and the latter and tuber ischii, being careful of the vessels and nerves. Seek the bursæ over the great trochanter, the tuber ischii, and between the insertion of the gluteus maximus and the origin of the vastus externus, then throw towards the middle line the origin of the great gluteus and trace the sacral nerves to the surface of the great sacro-sciatic ligament. On tracing these offsets to their origin they will be found to come from the loop of the outer posterior branches of the first three sacral nerves on the great sacro-sciatic ligament. The looped arrangement will be seen on removing a fibrous layer which covers them. They should be

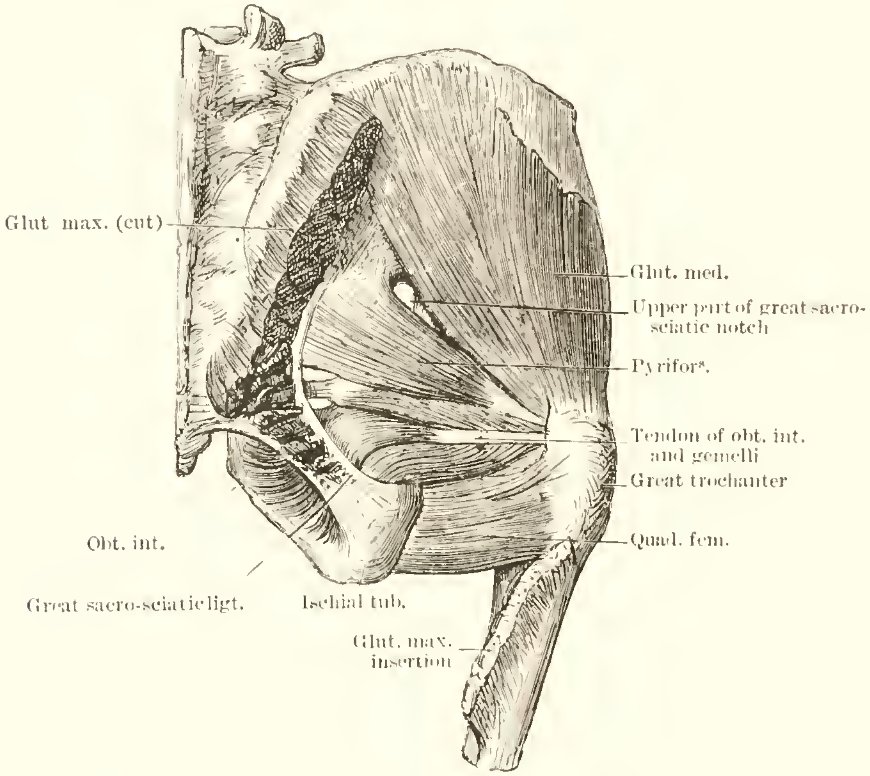


FIG. 302.—MUSCLES OF THE RIGHT GLUTEAL REGION.

traced inward beneath the multifidus spinæ to the posterior sacral foramina.

The **Gluteus Medius** is situated mainly in front of the maximus; is broad, thick, and triangular, and passes from the outer surface of the ilium to the femur. Its base arises from between the crest and superior curved line of the ilium, and from the gluteal aponeurosis covering its anterior part. The fibres converge to a strong flattened tendon which forms its apex, and which is inserted into the oblique line at the outer surface of the great trochanter, extending from the tip behind to the root in front. A small bursa is found between it and the great trochanter.

Relations.—Above, at its posterior third is the gluteus maximus. *Behind* are the cutaneous vessels and nerves before mentioned. The tensor fasciæ femoris and deep fascia are superficial to it in front. Its *anterior*

inferior border is blended with the gluteus minimus and tensor fasciæ femoris, and its *posterior edge* is parallel with the pyriformis; the gluteal vessels and superior gluteal nerve being between. Its deep surface is in relation with the gluteus minimus and the gluteal vessels and superior gluteal nerve.

Actions.—Acting from above it abducts and extends the thigh. Its *anterior* fibres rotate the femur in, and the *posterior* rotate it out. In walking it assists the adductors in moving the femur forwards. Acting from the femur it supports the pelvis, and consequently the spine upon the head of the femur.

Nerve.—It is supplied by the superior gluteal nerve.

Varieties.—This muscle may also be bi-laminar. It may be joined

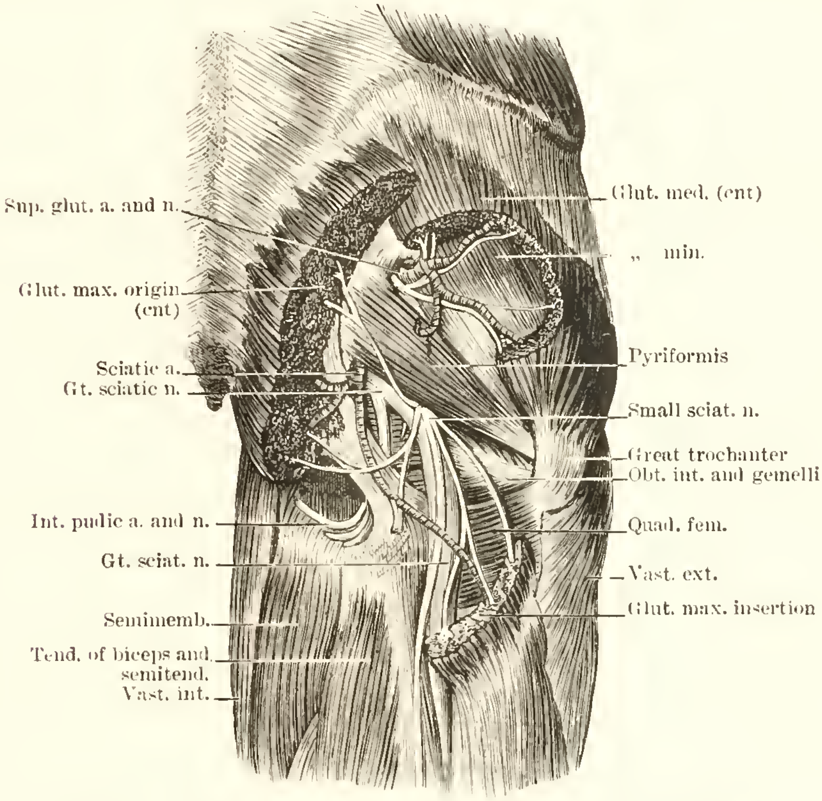


FIG. 303.—DEEP DISSECTION OF RIGHT GLUTEAL REGION

behind to the tendon of the pyriformis by an aponeurotic slip, or once in fifteen subjects a bursa (Loder's bursa) may separate them.

Dissection.—Detach the muscle near its origin and near its insertion, separate it from the minimus to which its anterior border is closely blended, and reflect it. The divisions of the gluteal artery and the superior gluteal nerve will now be exposed, and must be cleaned. The branches of the artery to this muscle will be cut in reflecting it.

The **Gluteal Artery** is the largest branch of the internal iliac, and is apparently the continuation of the posterior division of that vessel. Only the part of it external to the pelvis is now dissected. It is a thick short trunk, which leaves the pelvis above the upper border of the pyriformis, and at once divides into a superficial and deep branch. The *superficial branch* passes up beneath the gluteus maximus, giving numerous twigs

which supply that muscle and the skin covering it, and also that over the sacrum, and anastomoses with the *posterior* branches of the sacral arteries. The *deep branch* runs up and out between the gluteus medius and minimus, and divides into two, one being superior, the other inferior. The

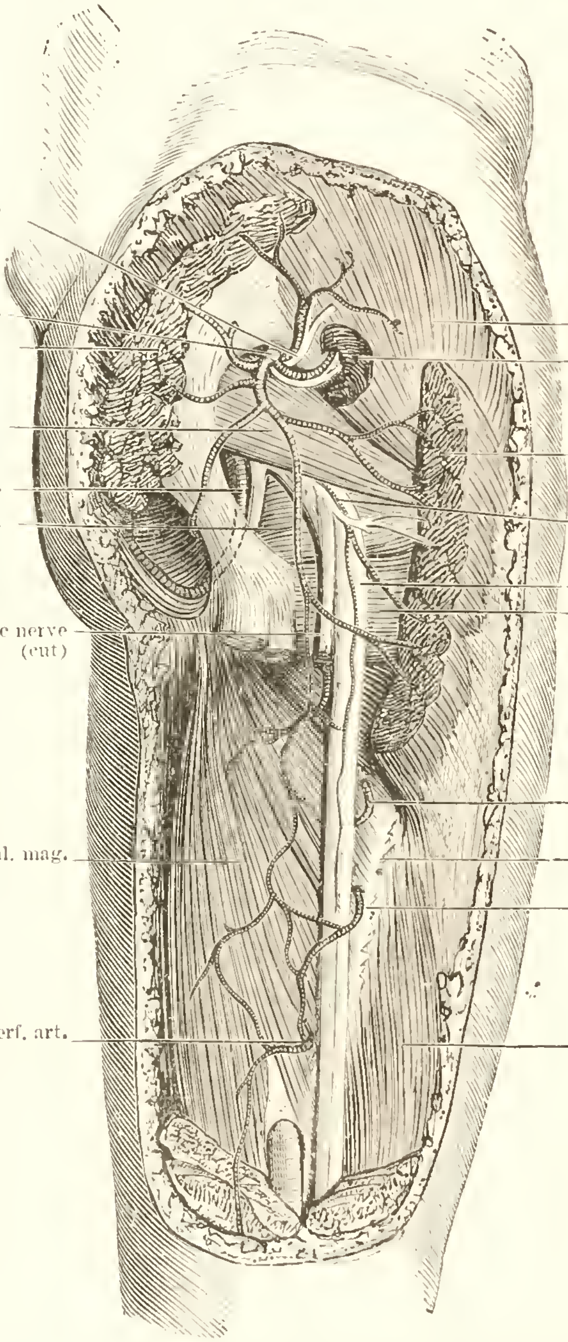


FIG. 304. MUSCLES, VESSELS, AND NERVES OF THE RIGHT GLUTEAL REGION.

The inner and outer hamstrings are shown cut above and below, and the femoral artery emerging from Hunter's canal is represented.

superior runs along the upper border of the gluteus medius towards the anterior superior spine, anastomosing with the circumflex iliac, and ascending branch of the external circumflex artery. The *inferior* branch passes down and out with the nerve over the gluteus medius to the great tro-

chanter, supplying the glutei and tensor fasciæ latæ, and inosculates with the ascending branches of the external circumflex artery. Some branches pierce the gluteus medius to nourish the hip joint. The *gluteal vein* enters the pelvis above the pyriformis and ends in the internal iliac vein. It is accompanied by some lymphatic vessels which debouch into the lumbar glands.

The **Superior Gluteal Nerve** is given off from the back part of the lumbo-sacral cord, and leaves the pelvis through the great sacro-sciatic foramen, above the pyriformis in company with the gluteal artery, and divides into a superior and inferior branch. The *former* runs along the

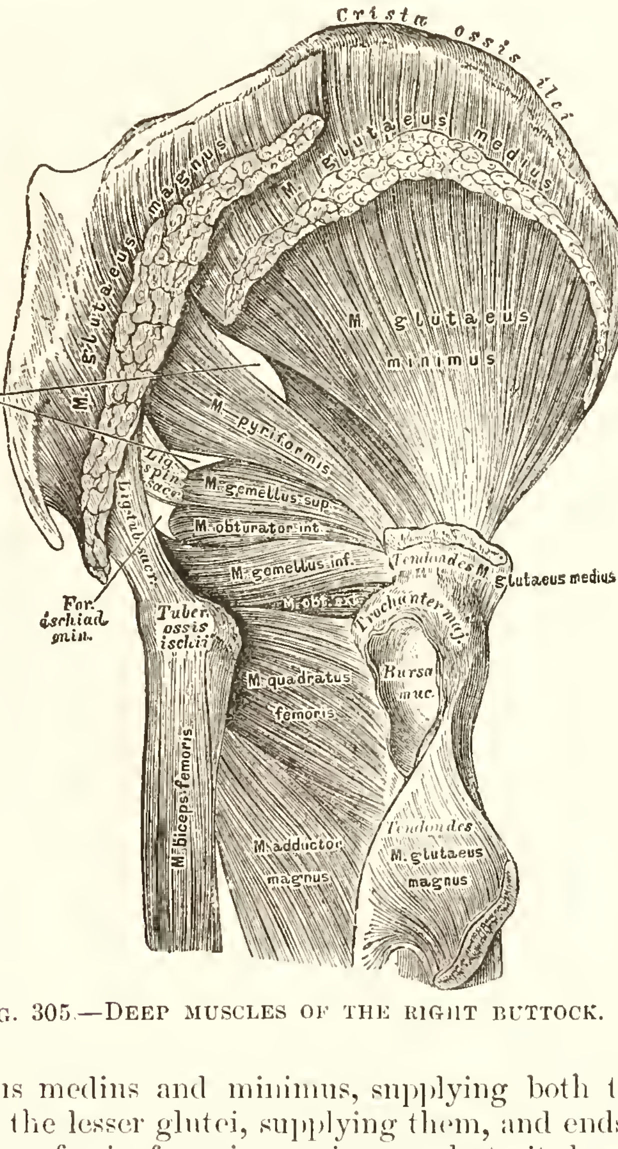


FIG. 305.—DEEP MUSCLES OF THE RIGHT BUTTOCK.

line of the gluteus medius and minimus, supplying both these muscles. The *latter* crosses the lesser glutei, supplying them, and ends in the under surface of the tensor fasciæ femoris, passing nearly to its lower end.

The **Gluteus Minimus** is the smallest of the glutei, is triangular, and is placed immediately beneath the medius. It passes from the back of the ilium over the posterior and upper surface of the hip joint to the great trochanter. It arises from the surface between the middle and inferior curved lines on the dorsum ilii, and from the upper margin of the great sacro-sciatic foramen. The fibres pass to the deep surface of an apo-

neurosis which ends in a tendon which is inserted into an impression on the anterior border of the great trochanter, where it is blended anteriorly with the gluteus medius and with the capsule of the hip. A bursa is often found between its tendon and the great trochanter.

Relations.—*Superficial* to it are the gluteus medius, the gluteal vessels and superior gluteal nerve. By its *deep surface* with the ilium, the long head of the rectus, and the back of the capsular ligament. Its *anterior border* is blended with the medius, and the *posterior* overlays the pyriformis with which it is often joined.

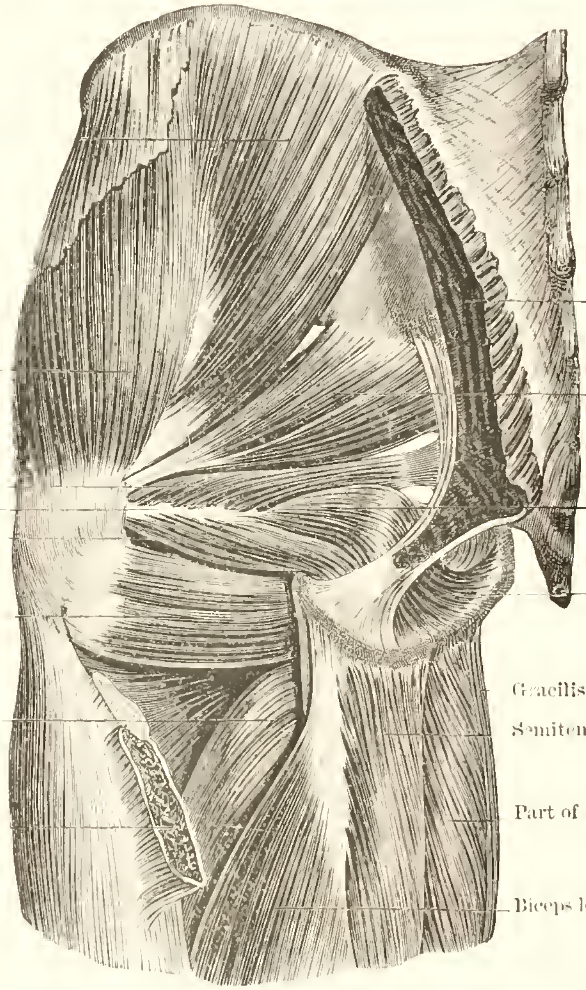


FIG. 306.—MUSCLES AT THE BACK OF THE LEFT HIP.

The great sciatic ligament is shown.

Actions.—It abducts and rotates outwards the femur, and in walking it and the medius bring the limb forward. Acting from the femur it will steady the pelvis on the head of the thigh bone, and assist the medius in balancing the trunk on the femur, and standing on one leg.

Nerve.—The superior gluteal.

Varieties.—It may be divided into an anterior and posterior part, or may send slips to the outer part of the origin of the vastus externus, the pyriformis, or superior gemellus, and it may be divided into an anterior and posterior part.

Dissection.—Reflect this muscle by cutting through it near its origin. Seek the long head of the rectus beneath it and close above the hip joint. On throwing down the muscle towards its insertion its intimate connection with the hip capsule will be evident. The deep vessels to the joint will also be noticed. The long outer or reflected head of the rectus will now be seen to reach almost horizontally outwards to a groove above the margin of the acetabulum. It should be traced forward to its junction with the short head of the rectus, and its connection with the capsule of the hip must be made evident.

The **Pyriformis** is triangular and flat, and runs parallel with the posterior margin of the gluteus medius. It arises within the pelvis from the

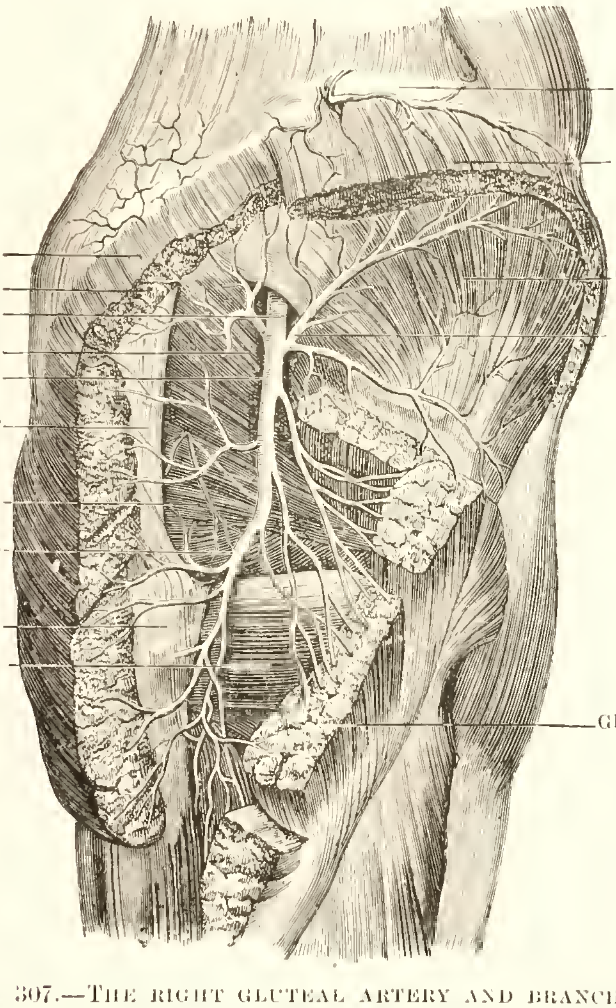


FIG. 307.—THE RIGHT GLUTEAL ARTERY AND BRANCHES.

front of the sacrum by three fleshy digitations between the first, second, and third anterior sacral foramina. A few fibres come from the inner margin of the great sacro-sciatic foramen, and from the anterior surface of the great sacro-sciatic ligament. It leaves the pelvis through the great sacro-sciatic foramen, and is inserted by a rounded tendon into the upper border of the great trochanter between the two lesser glutei, being often blended with the tendon of the obturator internus.

Relations.—Its pelvic relation will be seen in another dissection. External to the pelvis its *anterior surface* is in contact with the inno-

minate bone and capsular ligament. Its *posterior surface* is in relation with the gluteus maximus. Its *upper border* with the gluteus medius and minimus, being separated from it by the gluteal vessels and superior gluteal nerve. By its *lower border* it is in relation with the gemellus superior; the sciatic vessels and nerves, the internal pudic vessels and nerve, and the nerve of the obturator internus, passing out and into the pelvis between the muscles. At its insertion it is covered by the gluteus medius, and is separated from the hip joint by the gluteus minimus.

Action.—It is an external rotator when the femur is pendant, and if the hip be bent it abducts the limb. It also draws the pelvis forward if it have been inclined backwards. When both limbs are fixed these muscles balance the pelvis and steady it on the femoral head. In standing on one leg it can rotate the trunk to the opposite side.

Nerves.—Special branches from the sacral plexus.

Varieties.—It may be absent. It is often pierced by the great sciatic nerve or by its outer branch, when it divides high up and is thus more or less completely divided into two portions. It may be blended with the gluteus medius or minimus, obturator internus or superior gemellus, and may have only one or two attachments to the sacrum, and be inserted into the back of the hip capsule.

Dissection.—Cut through the pyriformis at its middle and reflect it. Then trace the sciatic and pudic vessels and nerves to their source and termination, as far as the present position of parts will allow. Some small nerves to the hip joint, to the obturator internus, gemellus superior and inferior, and quadratus, will be seen by raising the great sciatic nerve.

Blood Vessels.—The **Sciatic Artery** is the larger of the two terminal branches of the anterior division of the internal iliac, and supplies the gluteal region at its lower part, the gluteal artery supplying the upper. It leaves the pelvis through the lower part of the great sacro-sciatic foramina behind and external to the internal pudic, and passes between the pyriformis and coccygeus, and accompanies the small sciatic nerve between the trochanter major and tuber ischii, passing over the gemelli and obturator muscles to the lower border of the gluteus maximus. Here it gives off several branches which accompany the superficial offsets of its companion nerve, and after supplying the deep muscles it is much reduced in size, and is continued along the back of the thigh. External to the pelvis its branches are the *coccygeal*, *inferior gluteal*, *comes nervi ischiatici*, *muscular* and *articular*.

The *Coccygeal Branch* is given off close to the foramen; it pierces the great sacro-sciatic ligament, and the gluteus maximus which it supplies, and passes to the skin and cellular tissue at the back of the coccyx and lower part of the sacrum, and anastomoses with its fellow.

The *Inferior Gluteal Branches* are three or four, and supply the gluteus maximus.

The *Comes Nervi Ischiatici*, or companion to the great sciatic nerve, is a long, slender, and somewhat tortuous branch which pierces or enters the nerve near the pelvis and runs in its substance to the lower part of the thigh.

The *Muscular Branches* enter the obturator internus, gemelli, and quadratus. The branch to the latter, accompanied by the nerve to that muscle, passes beneath the gemelli and obturator internus, giving branches

to the inferior gemellus and the hip joint. These anastomose with the gluteal, internal and external, circumflex and superior perforating arteries in the upper part of the hamstring muscles.

a. Iliac crest.
b. Gt. sacro-sciatic ligt.
c. Gt. trochanter.
d. Skin around anus.
e. Gt. sciatic nerve.
f. Inner hamstrings.
g. Head of fibula.
1. Gluteal a.
2. Pudic a.
3. Sciatic a.
4. First perforating.
4'. Its branch to flexors.
5. Second perforating a.
6. Third ,,
7. Popliteal a.
8. On tendon of add. mag. just above sup. int. artic. a.
9. Anastomoses of sup. ext. artic.
10. Sural.
11. Ant. tibl. recurrent.

FIG. 308.—ARTERIES OF THE LEFT BUTTOCK, BACK OF THIGH, AND POPLITEAL SPA (TIEDEMANN).

The *Articular Branches* are distributed to the back of the hip joint. The *Anastomotic Branch*, variable in size, passes to the root of the

great trochanter, where it joins the gluteal, and ascending branch of internal circumflex.

The **Pudic Artery** is the smaller of the two terminal branches of the anterior division of the internal iliac, and is smaller in the female. It supplies the perineum and the external organs of generation. Only a small portion of the vessel is now visible. This passes down and out through the lower portion of the great sacro-sciatic foramen and quits the

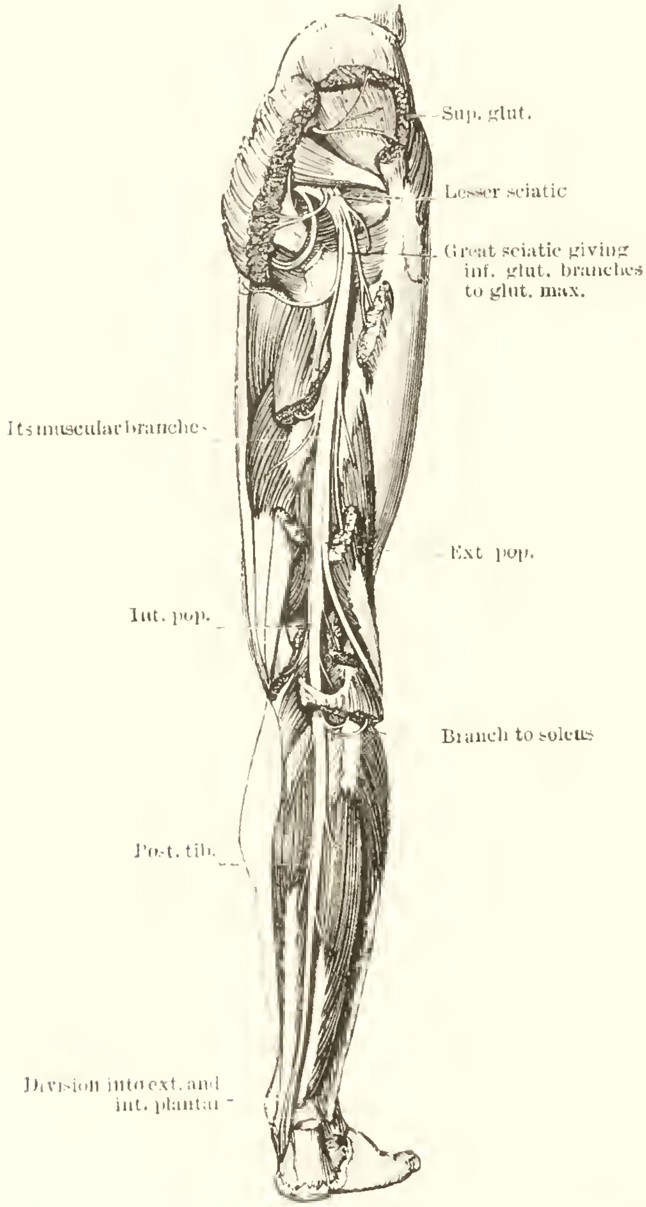


FIG. 309.—DEEP NERVES OF THE BACK OF THE RIGHT THIGH AND LEG.

pelvis between the pyriformis and coccygeus, and crossing the spine of the ischium lies internal to the sciatic artery and enters the perineum through the lesser sacro-sciatic foramen on the inner side of the tuber ischii, within the obturator fascia.

Varieties.—It may be small or defective in some of its branches. These will be noticed in the dissection of the perineum and pelvis.

The perineal portion of the artery has been dissected with that region. A small branch passes over the back of the sacrum and inosculates with the branches of the gluteal and sciatic vessels, and a twig from it accompanies the nerve to the obturator internus.

The veins accompanying the pudic and sciatic arteries receive branches corresponding to those of the artery, and pass into the pelvis through the foramen *below* the pyriformis and empty into the internal iliac vein. Lymphatic vessels accompany these veins.

Nerves.—The sciatic and pudic nerves leave the pelvis below and in front of the pyriformis, the former supplying the lower limb mainly beyond the gluteal region; the latter being destined for the perineum and outer genital organs.

The **Small Sciatic Nerve** comes from the anterior primary branches of the third and fourth sacral nerves. It accompanies the sciatic artery to the lower border of the gluteus maximus, where it gives several cutaneous branches up and down, which have already been dissected. It then passes along the back of the thigh beneath the fascia lata, and becoming smaller, it pierces the deep fascia at the lower part of the popliteal region, and becoming cutaneous accompanies the external saphenous vein to below the middle of the leg, where it communicates with the external saphenous nerve. Its branches are cutaneous, and two or three muscular to the gluteus maximus.

The *Inferior Gluteal* are its muscular branches. They are large, and are distributed to the under surface of the gluteus maximus in its lower two-thirds.

The *Cutaneous Branches* are internal, ascending, and descending.

The *Internal Cutaneous Branches* supply the skin at the upper and inner side of the thigh at its posterior aspect. One branch longer than the rest, called the *inferior pudendal*, curves forward below the tuber ischii, pierces the fascia lata on the outer side of the ischiatic ramus, and supplies the skin of the scrotum or labium, joining the superficial perineal nerve.

The *Ascending* set, two or three in number, supply the skin and fascia over the lower-third of the great gluteus.

The *Descending* filaments cross along the outer side of the thigh, and supply the integument as far as its middle.

The **Great Sciatic** is the largest nervous trunk in the body, measuring about three quarters of an inch in breadth. It is the continuation of the lower part of the sacral plexus, and is formed by the anterior primary branches of the four first sacral nerves. It leaves the pelvis through the great sacro-sciatic foramen, in front of, and then below, the pyriformis. It passes between the great trochanter and tuber ischii, along the back of the thigh, resting on the obturator and two gemelli, quadratus femoris, and abductor magnus, external to the small sciatic nerve and the sciatic artery, and under the long head of the biceps, and at the lower third of the femur divides into its two large terminal branches, viz. the *internal and external popliteal* nerves. It may divide at any point between the sacral plexus and the lower third of the thigh. When it divides high up the two nerves run side by side, or at their commencement they may be separated by the pyriformis, or one of them may pierce it. It supplies the muscles of the back of the thigh and those of the leg and foot, and nearly

the whole of the skin of the leg. It does not usually give any branch to the buttock, but one or two articular filaments to the hip may come from it and pierce the back of the capsule. These and the muscular branches are given off before the nerve divides into the popliteals, the muscular being given off beneath the biceps and supplying the biceps, semitendinosus, semimembranosus, and part of the adductor magnus.

The **Pudic Nerve** comes usually from the third and fourth anterior primary branches of the sacral plexus, and leaves the pelvis in the same way as the sciatic nerves, crossing the ischiatic spine in company with the artery, and passing to the perineum through the lesser sacro-sciatic foramen. It does not give off any branch to the buttock, and it is generally internal to the artery.

Muscular Branches are given off from the sacral plexus to the upper part of the gluteus maximus and the external rotators, excepting the obturator externus. The nerve to the obturator internus accompanies the pudic nerve over the ischial spine and through the lesser notch to the inner surface of the muscle. The nerve to the superior gemellus is small and enters its superficial surface at its inner end. The nerve to the quadratus and inferior gemellus is very small, and is accompanied by an artery, and passes beneath the gemelli and obturator internus to end in these vessels. It gives articular filaments to the hip. This nerve sometimes comes from the upper part of the great sciatic. Some articular filaments are given off from the plexus and pierce the back of the capsular ligament.

Dissection.—Hook aside the sciatic nerves, and, if necessary, reflect the sciatic artery and its branches; rotate the limb inwards, and clean the obturator and gemelli. Separate the quadratus femoris from the upper border of the adductor magnus, and between them define the tendon of the obturator externus, being careful of the ascending branch of the external circumflex artery, which passes up along the upper border of the adductor magnus.

The **Gemellus Superior.**—The Gemelli are two small muscular bundles accessory to the tendon of the obturator internus, which is received in a groove between them. The *superior* is the higher and smaller of the two, and arises from the outer and lower part of the ischial spine, and is inserted into the upper part of the obturator tendon. It is often absent.

Relations.—The sciatic vessels and nerves rest on it, and its *deep* surface is in contact with the upper part of the hip capsule.

Nerve.—From the sacral plexus.

The **Gemellus inferior** is more constant and larger than the superior. It arises from the upper part of the hinder border of the tuberosity of the ischium and blends with the lower part of the obturator tendon. It, with the superior, accompany this tendon to the upper border of the great trochanter. It is not so frequently absent as the superior.

Relations.—On its *posterior* surface are the sciatic vessels and nerves, its *anterior* surface is in contact with the back of the capsular ligament of the hip, and its *lower border* is in contact with the tendon of the obturator externus and with the quadratus femoris.

Actions.—They assist the obturator internus.

Nerve.—From the sacral plexus.

The **Obturator internus** arises inside the pelvis. Its origin cannot now be seen. Its fibres pass back and down, and end in four or five tendinous

bands on its deep surface. These are reflected over the inner trochlear surface of the ischiatic tuberosity at a right angle. It leaves the pelvis by

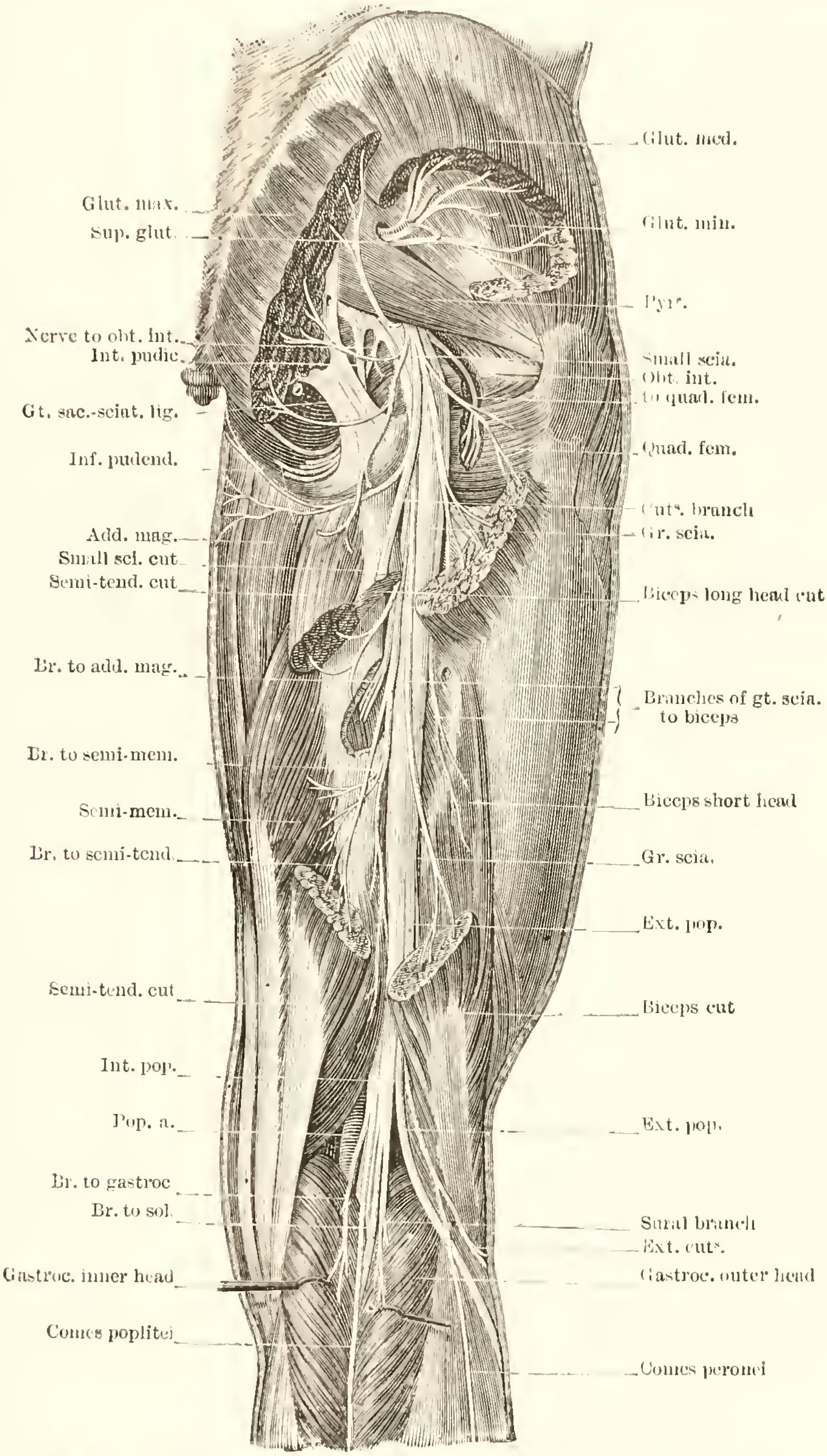


FIG. 310.—BRANCHES OF RIGHT SCIATIC AND POPLITEAL NERVES.

the lesser foramen and the tendinous bands join in a single flat tendon, which passes horizontally out, and after receiving the gemelli, which meet

beneath it, is inserted into the upper border of the great trochanter in front of the pyriformis with which it is blended. Near its insertion the gemelli cover the tendon. The inner surface of the tuberosity is grooved for the reception of the tendon, and is covered with fibro-cartilage and lined by a large synovial bursa. A longish synovial sac is commonly found between the tendon and the hip capsule. It sometimes communicates with that between the tendon and the tuberosity of the ischium, the two then forming one sac.

Relations.—The sciatic vessels and nerves rest on its *posterior surface*,

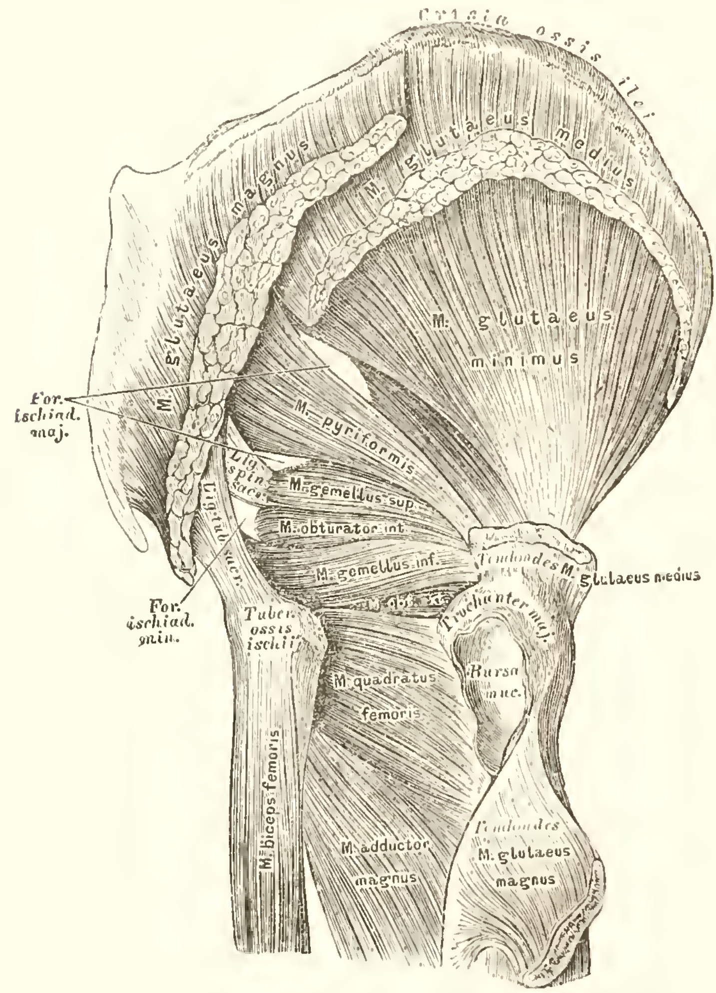


FIG. 311.—DEEP MUSCLES OF THE RIGHT BUTTOCK.

and its *anterior surface* is in contact with the back of the capsular ligament.

Actions.—It abducts and rotates out the femur. Acting from below it will erect the pelvis and balance it on the femur, and if standing on one leg it will take the pelvis to the opposite side.

Nerve.—A special branch from the sacral plexus coming from the junction of the lumbo-sacral with the first sacral.

The **Quadratus Femoris** is, as its name expresses, a quadrilateral muscle. It is flat and short, and passes horizontally out from the ischium to the great trochanter between the inferior gemellus and the upper edge of the

adductor magnus. It arises from the outer edge of the tuber ischii, by the side of the origins of the semi-membranosus and adductor magnus, and is inserted into the upper part of the linea quadrati on the posterior surface of the great trochanter, and for about two inches along the upper end of the femur above the attachment of the great trochanter. There is often a bursa between it and the trochanter.

Relations.—*Behind* it the gluteus maximus and sciatic vessels and nerves; *in front* the obturator externus, the trochanter minor (from which it is separated by a small bursa), the hip capsule, the internal circumflex vessels, and the nerves and vessels supplying it. *Above* is the gemellus inferior, and between its *lower border* and the upper edge of the adductor magnus is found one of the terminal branches of the internal circumflex artery. Its *upper border* is close to the inferior gemellus.

Actions.—It is a feeble external rotator if the femur be pendant, and it may abduct when the hip is bent. Acting from its femoral attachment it will turn the face to the opposite side, and will support the pelvis on the femur.

Nerve.—A special branch from the sacral plexus.

Varieties.—When the inferior gemellus is large this muscle may be absent, the former muscle supplying its place.

Directions.—Divide the gemelli and the quadratus about their middle and seek the small vessels and nerves which go to them. The termination of the internal circumflex artery and the obturator externus must be dissected.

The **internal circumflex** branch of the profunda is smaller than the external, and is given off from the inner and back part of the main trunk. It has been described in the dissection of Scarpa's triangle, and was shown there to divide into three branches. Two of these may be now seen: one which ascends beneath the quadratus to the digital fossa of the trochanter, where it anastomoses with the gluteal and sciatic arteries, and supplies the bone; the other may be found between the quadratus and abductor magnus, where it joins the superior perforating from the profunda and supplies the upper part of the hamstring muscles.

The *Obturator Externus* is a triangular flat muscle which has been dissected with the deep parts of the front of the thigh. In this dissection the tendinous part of the muscle is exposed, and will be seen passing below the hip and ascending to its insertion at the upper part of the digital fossa of the trochanter.

Relations.—*In front* are the psoas, iliacus, pectineus, gracilis, adductor longus, and brevis, and more externally its tendon is in contact with the posterior part of the capsule of the hip and femoral neck. Its *upper border* is in contact with the inferior gemellus. Its *posterior surface* is covered by the quadratus, except near the femur, and it is in contact with the obturator membrane from which it arises, and its lower border is in contact with the inferior gemellus.

Actions.—It is an external rotator when the femur is hanging, and it has a similar action when the hip is bent, thus differing from the other external rotators. It also supports the back of the hip joint. In the sitting posture it assists in flexing the hip instead of extending it. This muscle and the pyriformis help to draw forward the pelvis and to steady it on the femoral head.

Dissection.—The student must now clean the great sacro-sciatic ligament, again noticing the coccygeal artery and nerve which pierce it. Only a portion of the lesser ligament will be seen until the greater has been reflected. These ligaments pass from the sacrum, ilium, and coccyx, to the spine and tuberosity of the ischium.

The **Great Posterior, or Superficial Sacro-Sciatic Ligament** is triangular, thin and flat, and narrower in the middle than at its extremities. Its base is fixed to the posterior spinous process of the ilium, to the fourth and fifth transverse tubercles of the sacrum, and to the margins of the sacrum and coccyx at their lower part. It passes obliquely forwards, outwards, and downwards, and becoming thicker and narrower, is inserted into the inner margin and anterior part of the ischial tuberosity, increasing in breadth, and is prolonged forwards along the inner margin of the ischial ramus forming the falciform ligament. The free concave edge of this ligament is blended with the obturator fascia, forming a groove which lodges and protects the internal pudic vessels and nerves. Its upper and lower margins are concave.

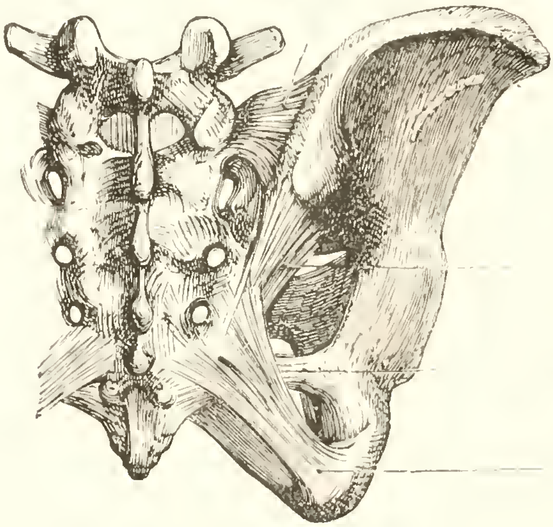


FIG. 312.—THE RIGHT SACRO-SCIATIC AND SACRO-ILIAC LIGAMENTS.

Between the upper two horizontal lines is the great sciatic foramen, and between the lower two is the lesser.

Relations.—On its *posterior surface* are branches of the sacral nerves, and gluteus maximus which arises from it. Its *anterior surface* is blended with the inner part of the lesser ligament, and is in relation with the obturator internus. Its *upper border* forms the lower boundary of the lesser sacro-sciatic foramen. Its *lower border* forms part of the limits of the perineum. The coccygeal branch of the sciatic and some twigs from the gluteal artery pierce it, as well as the coccygeal nerve.

Dissection.—Divide the great ligament near its origin, and reflect it to see the attachment of the small ligament. The **Lesser, anterior, or deep sacro-sciatic ligament** is triangular, thin, and much shorter and smaller than the preceding. It is attached internally by its broad base to the outer margin of the sacrum and coccyx, anterior to the attachments of the great ligament with which it is blended; its apex is inserted into the point and part of the posterior aspect of the spine of the ischium. It is not so strong as the great ligament.

Relations.—*Anteriorly* with the coccygeus muscle; *posteriorly* it is covered by the great ligament and crossed by the internal pudic vessels and nerves, and nerve to the obturator internus. Its *upper border* forms the lower limit of the great sacro-sciatic foramen, and its *lower edge* forms, with the ischial spine, part of the upper border of the lesser sacro-sciatic foramen.

These ligaments convert the large sacro-sciatic notch of the bony pelvis into two apertures, called the greater and lesser sacro-sciatic foramina.

The *Superior or great Sacro-Sciatic foramen* is bounded *above and in front* by the posterior border of the innominate bone; *behind* by the outer margin of the great sacro-sciatic ligament at its upper part; and *below* by the upper border of the lesser ligament and spine of the ischium. The pyriformis muscle passes through it, and *above* this, as already stated, the gluteal vessels and superior gluteal nerve leave the pelvis, the gluteal veins and lymphatics passing in. *Below* it emerge the sciatic vessels and nerves, the internal pudic vessels and nerves, and the nerve to the obturator internus.

The *inferior or small sacro-sciatic foramen* is bounded *in front* by the upper and inner margin of the tuber ischii; *above* by the lower border of the lesser ligament and the ischial spine; *behind* by the outer border of the lower part of the greater ligament. The obturator internus muscle passes out of the pelvis through it, and the internal pudic vessels and nerves, and the nerve to the obturator internus, pass in towards the perineum through it.

THE POPLITEAL SPACE.

Directions.—This space should be dissected before the back of the thigh, so that its upper muscular and tendinous boundaries may be more evident. The limb being in the same position as in the dissection of the buttock, an incision of six inches in length must be made behind the knee, and this should extend four inches below the joint. At each extremity of this vertical cut make a transverse incision, and raise the skin, turning one flap in and the other out.

After reflecting the skin the student must seek some slender cutaneous nerves and blood-vessels, which have the following positions:—In the middle line some small branches of the sciatic artery and nerve will be found perforating the deep fascia at the lower part of the space; some offsets of the internal cutaneous nerve will be found towards the inner side.

The dissector must clean and observe the arrangement of the fascia lata. He will note that this structure is here strengthened by fibres running in various directions, especially transversely, and is stronger on the *outer* side. It is connected laterally with the tendons bounding the space. The short or external saphenous vein perforates it usually at the *lower* part of the space, but occasionally higher up.

Dissection.—The fascia lata is to be removed without disturbing the positions of the small sciatic nerve and accompanying artery, and the short saphenous vein, which lie beneath it. The fat contained in the

space is to be carefully removed without injuring the vessels and nerves contained in it.

Relation of Parts.—The dissector must now make himself conversant with the limits and contents of the space.

The **Popliteal Space** is bounded *above the joint* on the inner side by the tendons of the sartorius, gracilis, semi-tendinosus, semi-membranous, and deeply by the tendon of the abductor magnus. *Internally below the joint* by the inner head of the gastrocnemius; *externally above the joint* by the biceps and outer head of the gastrocnemius and plantaris; *externally below the joint* by the outer head of the gastrocnemius. This space occupies the *lower-third* of the femur on its posterior aspect between the bifurca-

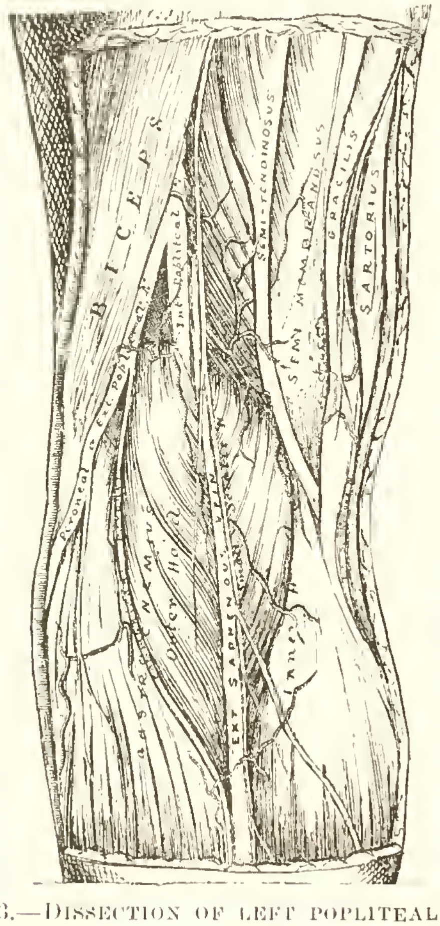


FIG. 313.—DISSECTION OF LEFT POPLITEAL SPACE.

Altered from Godlee.

tion of the linea aspera, and extends as far as the *upper-fifth* of the posterior aspect of the tibia. It is covered in by the skin, superficial fascia and fat, and deep fascia. The floor is formed by the *posterior-third* of the femur, just mentioned, the ligamentum posticum Winslowii, and upper part of the popliteal muscle covered by its fascia or aponeurosis.

While cleaning the space the student will find in the mid-line the large internal popliteal nerve, and on the outer side, in near connection with the biceps tendon, will be found the external popliteal or peroneal nerve. Branches from both these nerves, especially from the inner, may be traced from above downwards. They will be found to accompany the

respective superior and inferior articular arteries of the popliteal. Deep in the space will be found a nerve which occasionally arises from the great sciatic, but is more usually a branch of the external popliteal.

Underneath the nerve in the mid-line is the popliteal vein, and immediately beneath this, and closely adherent to it, is the popliteal artery. The superior and inferior articular branches of this vessel should be cleaned, and the accompanying veins traced into the popliteal vein. The muscular branches of these vessels should be traced out. On the upper

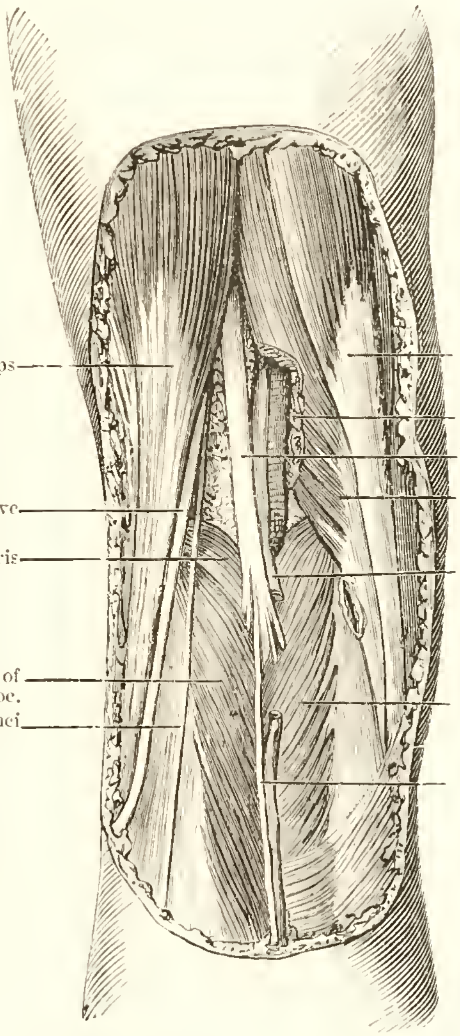


FIG. 314.—LEFT POPLITEAL SPACE.

A part of the short saphenous vein has been removed. The popliteal vein and artery are to the right of the internal popliteal nerve, the vein being in the middle.

part of the artery will be found the branch from the obturator nerve to the knee joint; and above, at the sides, and in front of the vessel, will be noticed some small lymphatic glands.

The space, after being cleaned, has a lozenge or diamond shape, but in the natural condition of the limb, the fascia lata binds the various structures together, and the space is limited to the posterior aspect of the joint. Note that the space is widest opposite the femoral condyles, because there the muscles are most separated; and observe that it is deepest

behind the articular end of the femur. The student will also note that this space communicates with the back of the thigh and leg beneath the muscles.

Internal Popliteal Nerve.—The internal popliteal nerve is larger than the external, and occupies the middle of the ham, lying posterior to the vein and artery. It is partly superficial to, and partly covered by, the gastrocnemius, like the artery, and extends through the space to the lower border of the popliteus muscle. In the space it gives the following

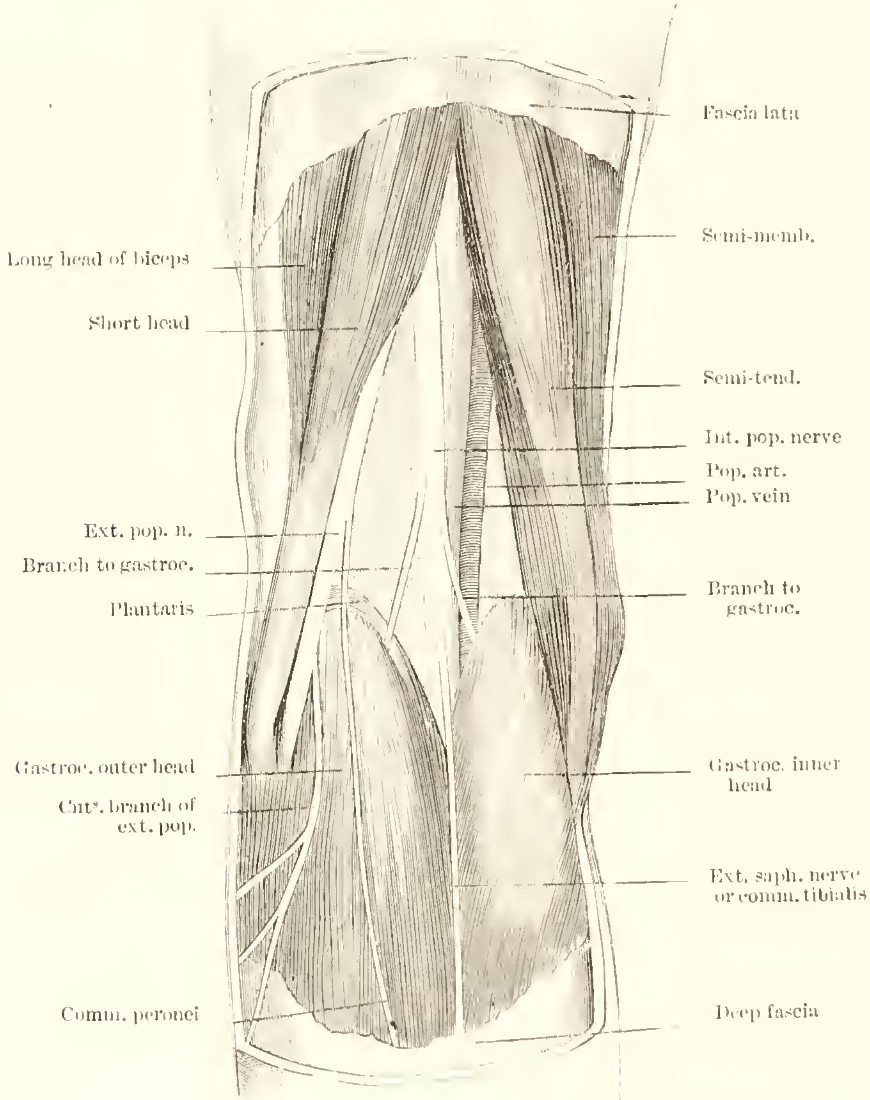


FIG. 315.—POPLITEAL NERVES OF THE LEFT SIDE.

articular and *muscular* branches :—small *articular* twigs to enter the posterior aspect of the knee joint, these are accompanied by articular vessels; nerve filaments which accompany the lower internal articular artery, and are of notable size, and pass to the interior aspect of the articulation; a branch accompanying the azygos artery and entering with it the back of the joint, through the posterior ligament. Between the origins of the gastrocnemius, *muscular* twigs from the popliteal nerves will be found

accompanying the muscular arteries. One of these passes beneath the gastrocnemius and supplies the soleus on its cutaneous surface. Another supplies the plantaris and both heads of the gastrocnemius; and yet a third may be traced round the lower border of the popliteus to enter its interior aspect. Its continuation to the back of the leg is called the *posterior tibial.*

The *External Saphenous Nerve* is its largest branch, and is *cutaneous* to the leg and foot. It lies on the gastrocnemius beneath the fascia, and will be subsequently seen piercing the deep fascia of the leg about its middle.

The **External Popliteal** or **Peroneal nerve** will be found, as just said,

FIG. 316.—DEEP DISSECTION OF LEFT POPLITEAL SPACE.

on the outer side of the space in close proximity to the biceps tendon. It is considerably smaller than the inner branch of the great sciatic nerve and accompanies the biceps for two inches, or till it is below the head of the fibula, where it pierces or penetrates the fibres of the peroneus longus, and in that muscle divides into its three terminal branches, viz. anterior tibial, musculo-cutaneous, and articular recurrent. Commonly, in the fibres of the tibialis anticus, a plexiform network will be found.

This nerve gives off articular and cutaneous branches; the *articular* nerves accompanying the external articular arteries to the joint. The cutaneous branch is named the *communicans peronei vel fibularis.* It

joins the external saphenous branch of the internal popliteal about the middle of the leg and soon perforates the fascia, giving offsets to the back and outer part of the leg in the lower half.

Directions.—The student after having dissected out the relations of the popliteal lymphatic vessels and glands to the artery, should define the articular branch of the obturator nerve which pierces the abductor magnus, and accompanies the popliteal artery to the back of the knee joint.

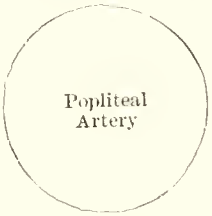
The **Popliteal Artery** is the continuation of the superficial femoral, and extends from the adductor opening to the lower border of the popliteus muscle, where it bifurcates into its two terminal branches, the anterior and posterior tibial arteries. It is comparatively superficial at its upper part, but at its lower lies deeply between the heads of the gastrocnemius. It passes obliquely from the inner side of the femur to the inter-condylar interval, and then occupies the middle of the space behind the knee joint.

Relations.—*In front* of it are the anterior limits of the popliteal space. *Behind* it are the popliteal veins in close contact with it; then the internal popliteal nerve, and at the lower part the external saphenous vein and the small sciatic nerve; to the *outer* and *inner* sides are the respective outer and inner boundaries of the space, and the external popliteal nerve is in external relation to it.

Relations of the Popliteal Artery.

In front are the femur, post. ligament of the knee, and the popliteus.

Inside is the semimembranosus, pop. vein, and int. pop. nerve.



Outside are the biceps, the pop. vein, and int. and ext. pop. nerve.

Behind are the pop. vein, internal popliteal nerve, branch from obturator nerve to the knee, part of the ext. saphenous vein, semimembranosus above, and gastrocnemius and soleus below, fascia and skin.

Varieties.—These are infrequent. It sometimes divides prematurely into its terminal branches, and this takes place most frequently opposite the bend of the knee joint.

Its *branches* may be unusual; thus it may divide into the anterior tibial and peroneal, the posterior tibial being very small or absent. In one case the popliteal artery is divided at once into three terminal branches, viz. the anterior and posterior tibial and peroneal. Sometimes there are several small *middle articular* branches. The *azygos articular* often arises from one of the other articular branches, and especially from the superior external articular.

Dissection.—Divide the inner head of the gastrocnemius, clear away the connective tissue, and seek the inferior articular branches of the popliteal artery and nerve, and the accompanying veins. The *inferior inner articular artery* will be found below the head of the tibia, with the articular nerve, and the *inferior outer* higher up between the tibia and fibula. Note that the vein and nerve change their position with respect

to the artery, i.e. they are first on the outer side, and then cross to the inner.

Branches.—The popliteal artery gives off, in the space, muscular and articular branches. The muscular branches are superior and inferior. The muscular set are usually three or four in number, are given off above the knee and supply the semimembranous and biceps muscles, and communicate with the perforating and muscular branches of the profunda. The lower ones, called sural, supply the gastrocnemius, plantaris, and soleus. The *cutaneous offset*, arising usually opposite the knee, accompanies the external saphenous nerve to the skin over the back of the leg.

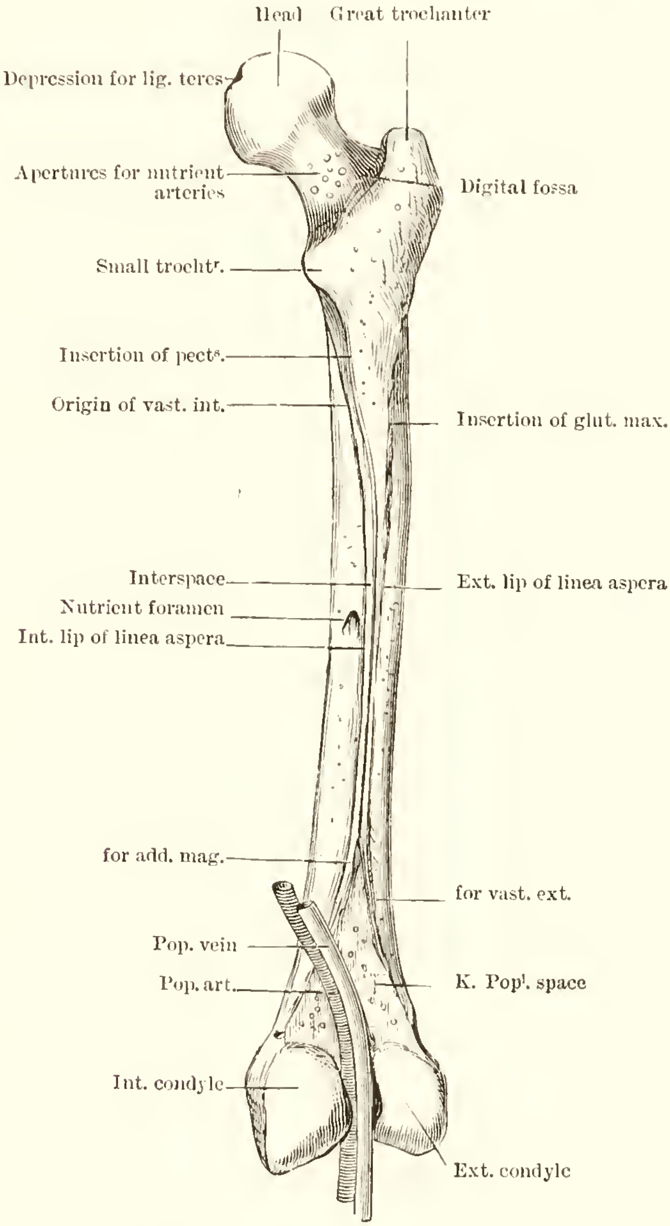


FIG. 317.—DIAGRAM TO SHOW THE RELATIONS OF THE POPLITEAL ARTERY AND VEIN TO THE FEMUR. RIGHT SIDE.

The *Articular Arteries* are superior and inferior. The superior ones are external and internal, and so are the inferior.

The *Superior External Articular* is given off from the outer side of the vessel and perforates the vastus internus and the external intermuscular septum, and after supplying the joint at its outer aspect, anas-

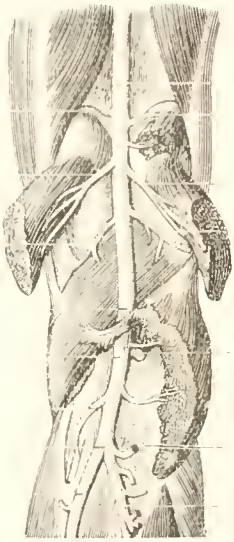


FIG. 318.—BRANCHES OF RIGHT POPLITEAL ARTERY.

tomoses with the descending branch of the external circumflex and with the inferior external articular.

The *Superior Internal Articular Artery* is often very small; part of it is beneath the tendon of the abductor magnus, and supplies the inner

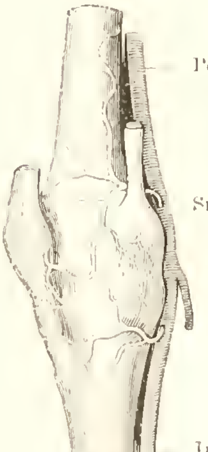


FIG. 319. RIGHT INTERNAL ARTICULAR ARTERIES.

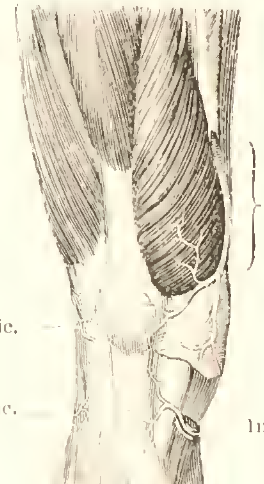


FIG. 320. ANASTOMOSES IN FRONT OF RIGHT KNEE.

aspect of the knee and the lower part of the vastus internus. It communicates with the deep branch of the anastomotica magna.

The *Inferior Articular Branches* will be found beneath the outer and inner heads of the gastrocnemius, the *inner* one being on a lower level than the outer. The *latter* is placed above the head of the fibula, whereas

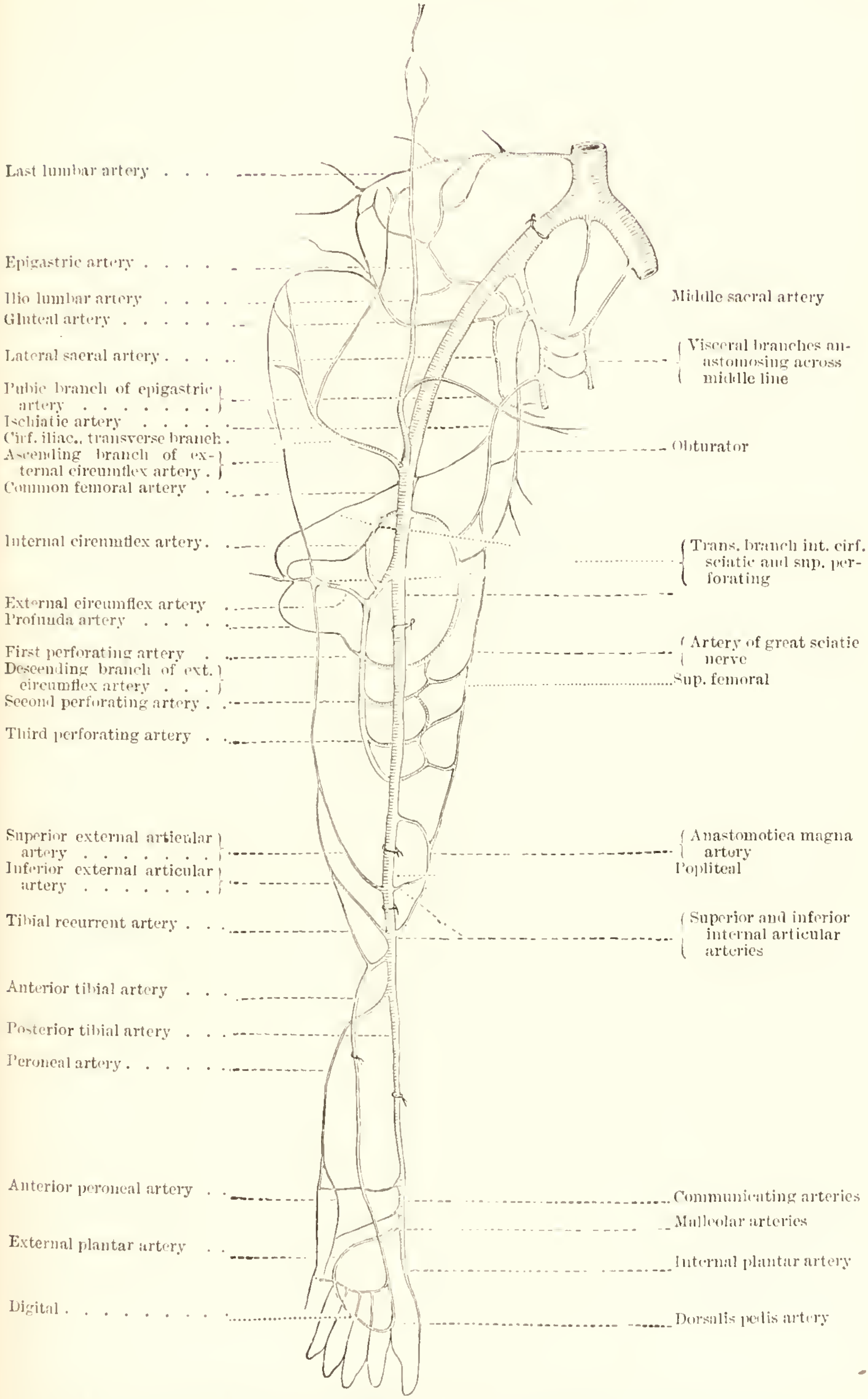


FIG. 321.—DIAGRAM OF ANASTOMOSES AND COLLATERAL CIRCULATION OF THE LOWER LIMB.

Altered from Smith and Walsham.

the *former* descends below the head of the tibia. Each will be traced beneath the outer and inner lateral ligaments.

The *Inferior External Articular* supplies the outer side of the knee, and sends a twig beneath the ligamentum patellæ to anastomose with the inferior internal articular and with the anterior tibial recurrent.

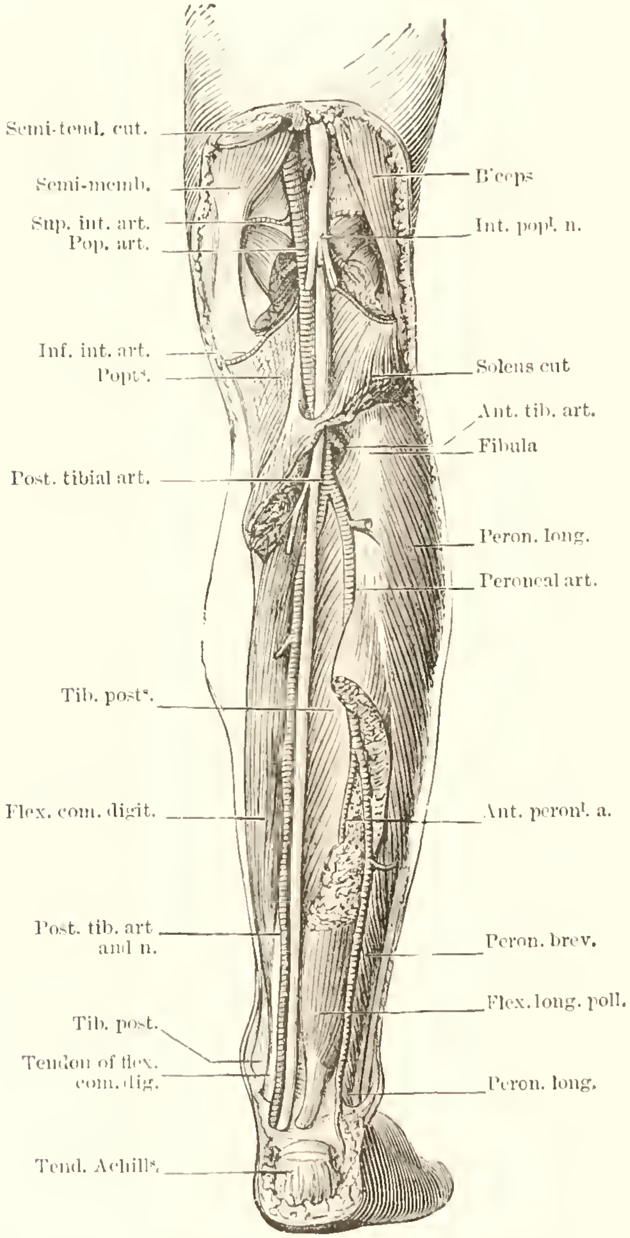


FIG. 322. DEEP MUSCLES, ARTERIES, AND NERVES OF THE BACK OF THE RIGHT LEG.

The posterior tibial artery and nerve are seen passing under the tendinous arch of the soleus. The soleus has been removed from the posterior aspect of the fibula and the gastrocnemius removed.

The *Inferior Internal Articular Branch* will be found ascending along the anterior border of the internal lateral ligament, and after anastomosing with the external articular and superior internal articular, is distributed to the head of the tibia and the knee joint.

The *Azygos Articular* is given off from the front of the popliteal

artery, and perforates the posterior ligament, being distributed to the synovial membrane, the fat, and the ligament.

The **Popliteal Vein** is formed by the union of the anterior and posterior tibial veins, and has much the same course and relations as the artery and internal popliteal nerve. It receives branches corresponding to those of the artery. It is superficial to the artery between the heads of the gastrocnemius, and at the lower border of the popliteus muscle is internal to the vessel, but gradually passes to the outer side where it becomes the femoral

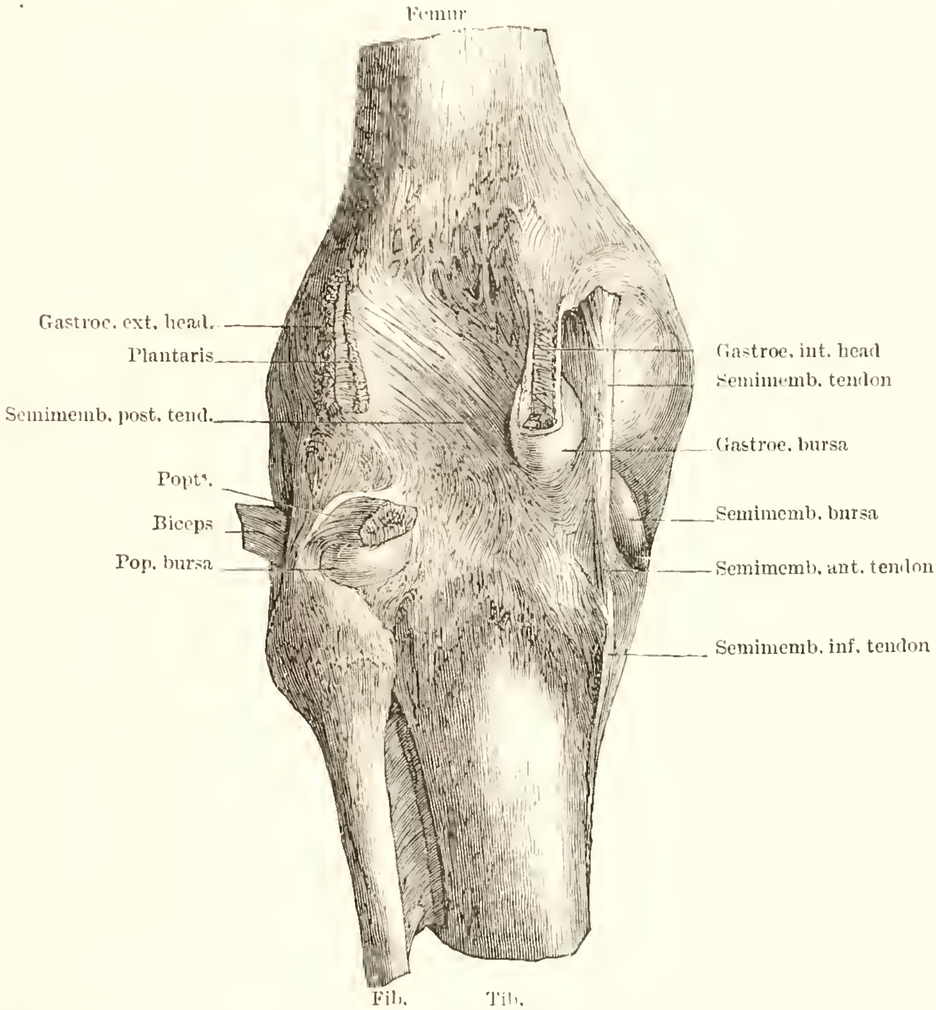


FIG. 323.—TENDINOUS INSERTIONS AND BURSA OF THE LEFT POPLITEAL SPACE.

at the abductor opening. The short saphenous empties itself into it about the middle of the space after perforating the deep fascia.

Varieties.—This vein is often double along the lower part of the artery, but less frequently so at its upper portion.

Directions.—The dissector should now examine the origin and insertion of muscles and tendons and the various bursæ in this region, and observe if they communicate with the knee joint.

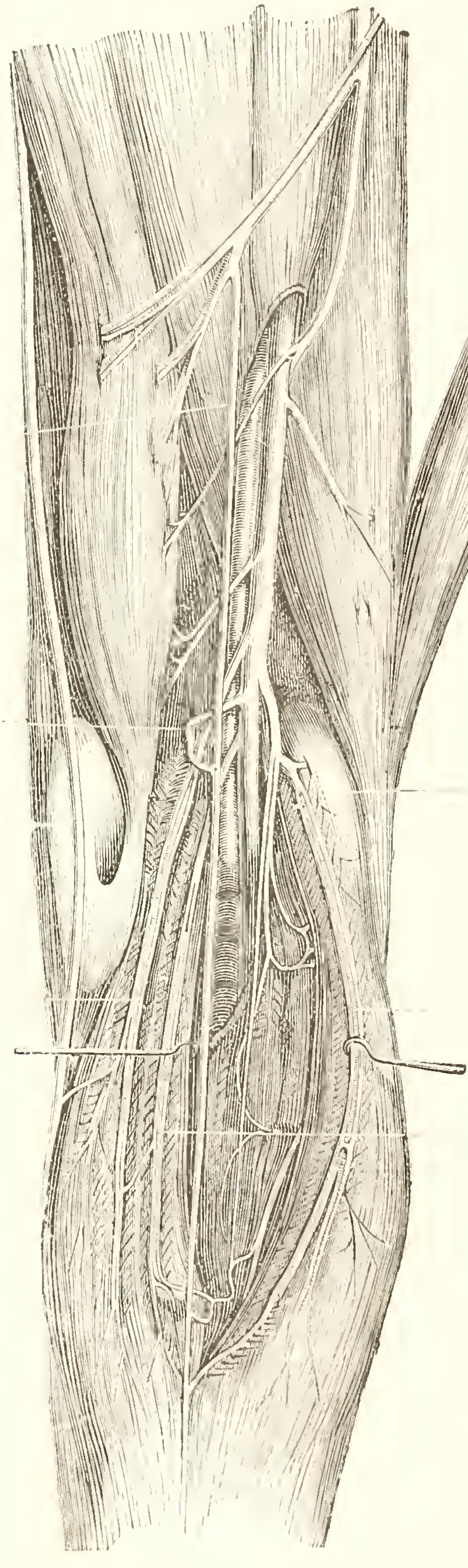


FIG. 324.—POPLITEAL VESSELS OF RIGHT SIDE.

The gastrocnemius is hooked aside.

THE BACK OF THE THIGH.

Dissection.—Make an incision down the middle of the back of the thigh from the gluteal region to the popliteal space, and reflect the skin to the sides. Some cutaneous vessels and nerves from the small sciatic in the middle line, and posterior branches from the external and internal cutaneous, on the outer and inner sides, must be sought in the fat between the layers of the superficial fascia. Trace these back to where they pierce the deep fascia, which should be carefully removed so as to avoid injury to the

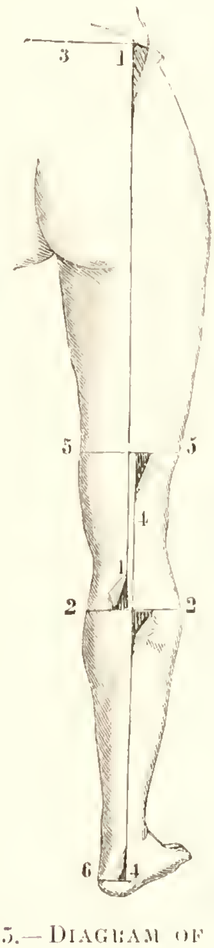


FIG. 325.—DIAGRAM OF INCISIONS.

The numbers show the direction of the incisions.

small sciatic nerve and artery; clean the hamstring muscles and the perforating branches of the profunda, also the branches of the great sciatic nerve to these muscles.

The **Small Sciatic Nerve.**—Between the gluteus maximus and the popliteal space, this nerve lies close beneath the deep fascia, and at the lower part of the ham becomes cutaneous, and for a short distance accompanies the external saphenous vein. It gives off some cutaneous filaments which pierce the fascia of the back of the thigh, and a larger branch is given off near the popliteal space.

Muscles.—There are three muscles at the back of the thigh which pass

from the pelvis across the back of the thigh and knee joint, and have been called the '*hamstring muscles*,' from their cord-like aspect at the sides of the ham, or popliteal space. That on the outer side is the biceps; the two on the inner are the semitendinosus and semimembranosus.

The **Biceps** is a long muscle placed on the posterior and outer aspect of the thigh. It *arises* by two heads, a long and a short. The *long* or *ischial* takes *origin* from the inner and lower side of the back of the tuber ischii, by a tendon common to it and the semitendinosus; the *short* or *femoral* head *arises* from the outer lip of the linea aspera between the vastus externus and adductor magnus, passing from just below the insertion of the gluteus maximus to within two inches of the outer condyle. It also arises from the posterior surface of the external intermuscular septum. The fibres from the *long-head* form a fusiform belly, and passing down and out, end in an aponeurosis on the *posterior* surface of the muscle and receive the fibres of the short head. This aponeurosis gradually contracts into a tendon which divides into two pieces, and after embracing the external lateral ligaments of the knee is *inserted* into two prominences on the outer side of the head of the fibula, and sends a strongish prolongation to the outer tuberosity of the tibia, and from this process an expansion is sent to the deep fascia of the leg. The tendon of this muscle forms the upper and outer boundary of the popliteal space.

Relations.—It is superficial except at its origin, where it is *covered* by the gluteus maximus. *Below* the deep and superficial fascia and skin are superficial to it, its *deep surface* is in relation with the upper part of the semimembranosus, the adductor maximus, vastus externus, and the great sciatic nerve. The popliteal artery and vein are to its inner side, and the external head of the gastrocnemius, the plantaris, and superior external articular vessels are in relation with its *deep* surface in the popliteal space. The external popliteal nerve is in close relation to its inner border in the popliteal space. This nerve must not be divided in tenotomy of the biceps tendon.

Action.—The hamstring muscles flex the leg upon the thigh. The biceps is naturally, then, a *flexor* of the leg, and when the leg is not fixed it can, in consequence of its direction obliquely down and out, *rotate* the tibia slightly *out*wards. Its *long-head* will extend the hip joint when the knee is straight. The leg being fixed the *long-head* will support the pelvis on the femur, and the *short-head* will draw down the femur so as to flex the knee in stooping.

Nerve.—The great sciatic.

Varieties.—There may be an extra long-head arising from the tuber ischii or from the upper part of the linea aspera or internal condyloid ridge, or other parts, and the short-head may be absent. Otto noticed a slip passing from the long head to the tendo-Achillis.

The **Semitendinosus** is situated at the posterior and inner aspect of the thigh; it is a somewhat slender muscle, and remarkable for the great length of its longer tendon. It *arises* from the back of the tuber ischii, from the inner side of the tendon common to it and the long head of the biceps, and also by fleshy fibres from an aponeurosis which unites the two muscles to the extent of about three inches. It is fusiform, and passes down and in, ending at the junction of the middle and lower thirds of the thigh in a long round tendon, which passes along the inner side of the popliteal space,

curves round the back of the inner condyle and inner tuberosity of the tibia, and is *inserted* into the upper part of the inner surface of the tibial shaft near to its anterior border just below the gracilis, to which it is united, sending an expansion to the deep fascia of the leg. Its tendon lies beneath the expansion of the sartorius, and a tendinous intersection is usually placed about the middle of the muscle on its *posterior* aspect. There is often a bursa between the insertion of the muscle and the tibia.

Relations.—*Posteriorly*, at its *upper* part, is the gluteus maximus; and at its lower part, the skin and fasciæ. Its *anterior* surface rests on the semimembranosus, adductor magnus, and inner edge of the gastroc-

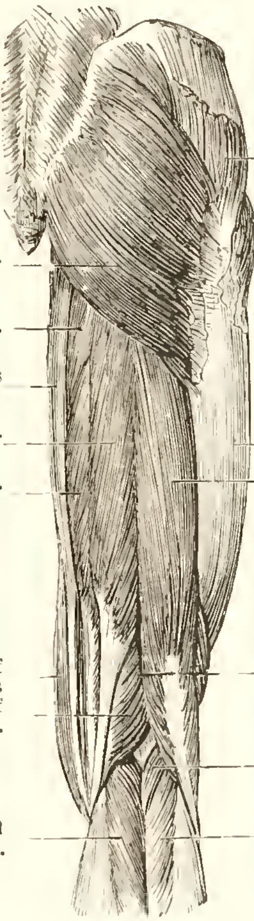


FIG. 326.—POSTERIOR MUSCLES OF THE RIGHT THIGH.

nemius. *External* to it, at its lower part, are the popliteal vessels, internal popliteal nerve, and superior articular vessels; and lower down it is in contact with the internal lateral ligament. Its *outer* border is also in contact with the biceps as far as the popliteal space.

Action.—It is a *flexor* of the knee, and afterwards can *rotate* the tibia *in*wards. If the knee be straight and the hip bent, it can depress the femur and extend the hip joint. It aids the other hamstrings in keeping the pelvis erect on the femur, and in feats of strength will assist them to draw the trunk directly backwards, as when the body is made to form an arch with its concavity backwards. In that sad malady called tetanus,

these muscles assist in forming that severe contraction of the body called opisthotonos, in which only the heels and the occiput touch the bed. This muscle, with the other hamstrings, will raise the trunk from the stooping position.

Nerve.—The great sciatic.

The **Semimembranosus** muscle takes its name from the membranous expansion on the *anterior* and *posterior* aspects of its *upper* tendon. It is placed at the back and inner side of the thigh, is tendinous at both ends, and *arises* by a thick tendon from the outer and upper facet on the back of

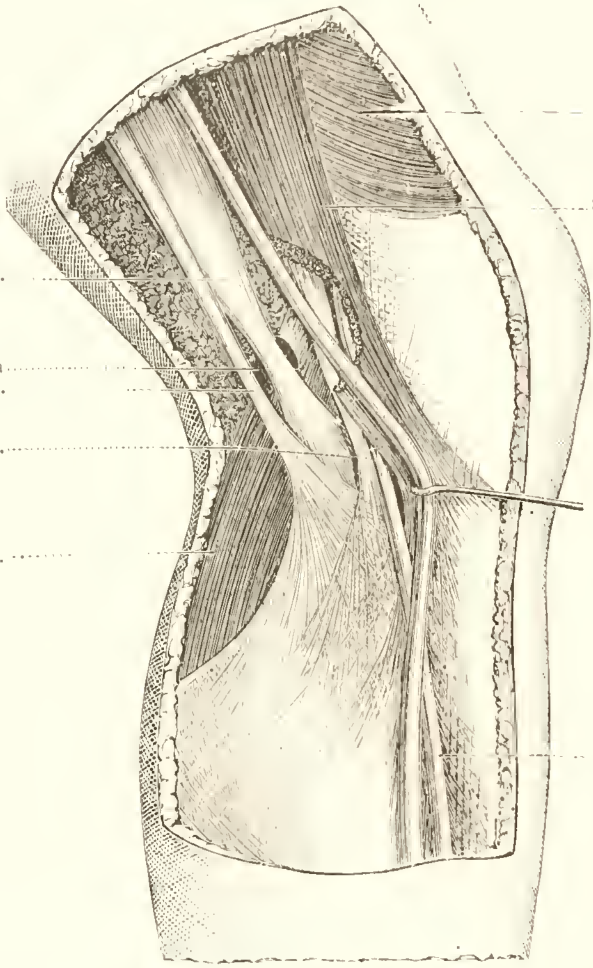


FIG. 327.—TENDONS, ETC., ON INNER SIDE OF LEFT KNEE.

An opening has been made at the posterior part of the sartorius to show the internal saphena nerve and tendon of gracilis. The bursa (6) is common to the inner head of the gastrocnemius and semi-membranosus.

the tuber ischii, above and external to the origins of the biceps and semi-tendinosus. It passes down, and is thick and fleshy where it bounds the popliteal space. Its *lower* tendon goes to be *inserted* in three pieces, the *middle* and strongest piece is inserted into the inner and back part of the internal tibial tuberosity, beneath the internal lateral ligament; this portion of the insertion sends an expansion over the popliteus muscle. The *internal* process of insertion is horizontal and passes beneath the internal lateral ligament, being inserted into a groove along the inner side of the internal tuberosity. The *posterior* process of insertion passes back,

up, and out to be inserted into the back part of the outer condyle of the femur, forming the greater part of the posterior ligament of the knee. These insertions will be more clearly made out when the knee joint is dissected. This muscle is made up of short fibres which extend obliquely between two aponeurotic expansions which pass down and up on the opposite sides of it, from its upper and lower tendons, for three quarters of its length. The expansion from the upper tendon covers the upper part of its anterior aspect, and that from the lower tendon invests the lower part

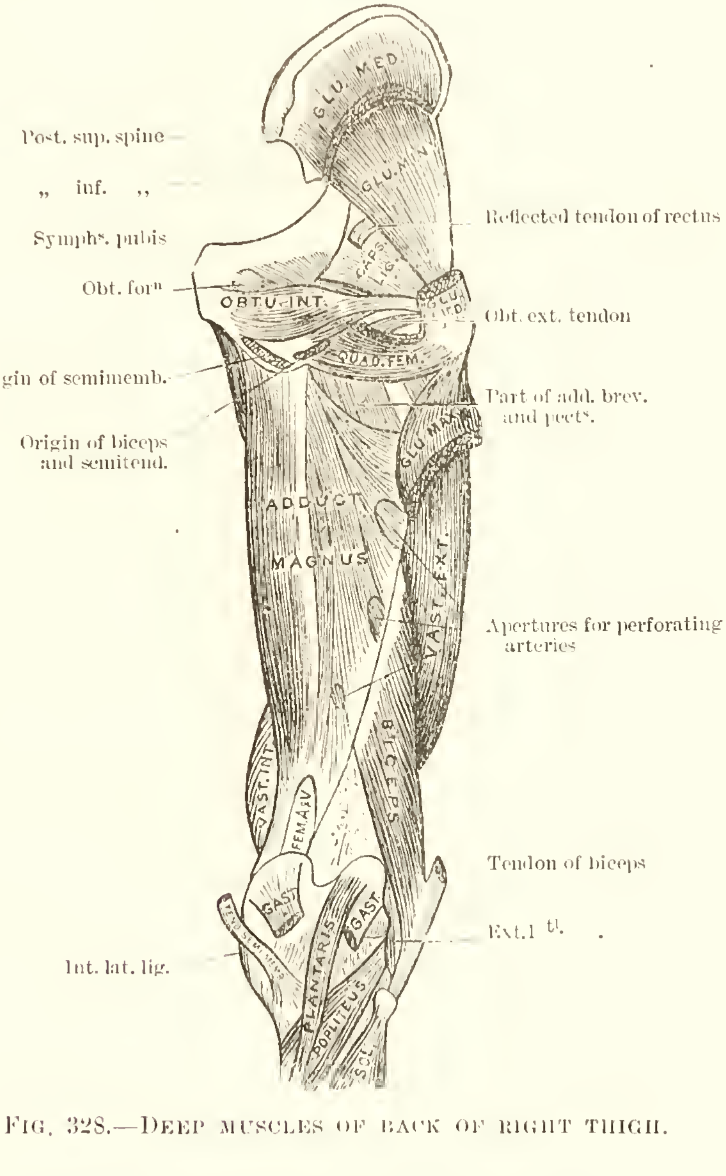


FIG. 328.—DEEP MUSCLES OF BACK OF RIGHT THIGH.

of its posterior aspect and contracts into the tendon of insertion. The tendon of this muscle, the semitendinosus, gracilis, and sartorius, form the inner and upper hamstring limit of the popliteal space.

Relations.—On its *posterior* surface the semitendinosus is placed in a hollow in the upper tendon, and the biceps and fascia lata are also in relation to this surface; by the *anterior* surface it is in relation with the adductor magnus, the popliteal vessels at their upper part, and the inner head of the gastrocnemius, from which its tendon is separated by a large

synovial bursa; by its *inner border* with the gracilis, and by its *outer* with the great sciatic nerve, the internal popliteal nerve, and the popliteal vessels.

Action.—It *flexes* and *rotates* the tibia *in* assisting the popliteus. With the knee straight it may extend the hip as in walking backwards; and will limit flexion of the hip. It will assist the other hamstrings in supporting the pelvis and the femur.

Nerve.—The great sciatic.

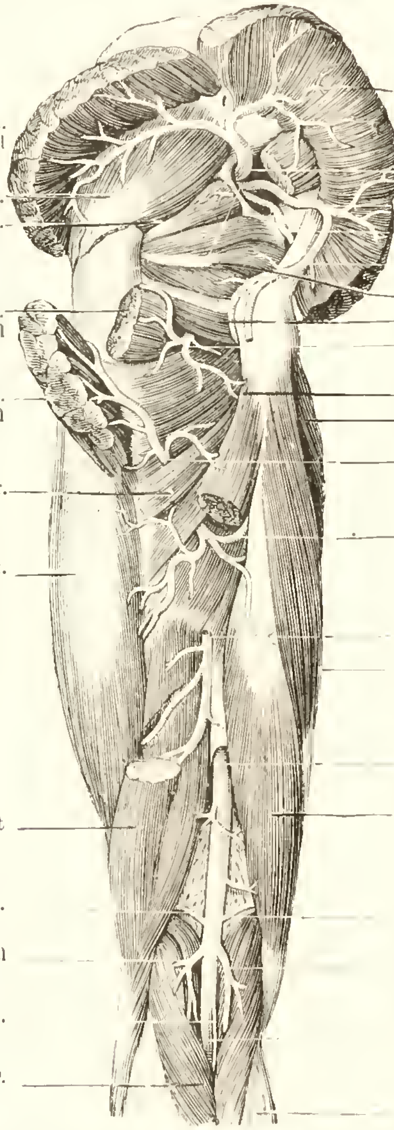


FIG. 329.—LEFT GLUTEAL, FEMORAL, AND POPLITEAL ARTERIES AND THEIR BRANCHES.

Varieties.—It may arise higher up, i.e. chiefly from the back of the great sciatic ligament. It may be double or even absent.

The **Great Sciatic Nerve**, below the pelvis, lies on the adductor magnus, and divides about the middle of the thigh into the two popliteal nerves. Sometimes, as has previously been said, it bifurcates much higher up. It is crossed by the long-head of the biceps and runs along the outer border of the semi-membranosus. At the upper part of the thigh it gives large

branches beneath the biceps muscle to all the hamstrings, and a small branch to the adductor magnus.

Dissection.—Divide the hamstring muscles about three inches from their origin and reflect them, noting the branches from the sciatic nerve and the perforating arteries to them. Trace the perforating and muscular arteries to where they pierce the adductor magnus, and clean the posterior surface of that muscle.

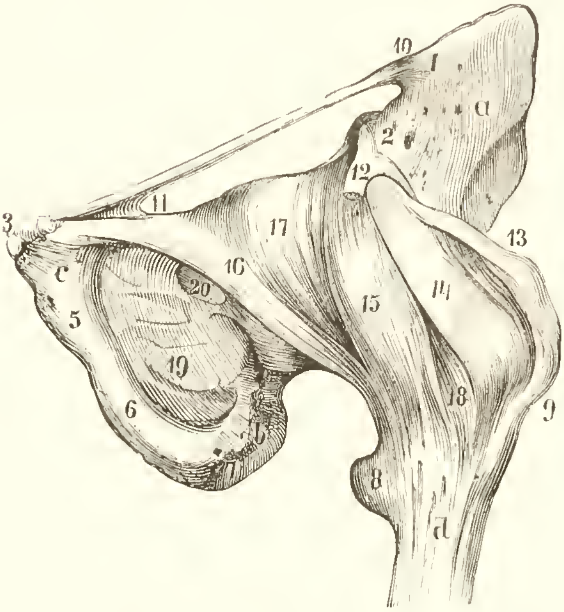
The **Adductor Magnus Muscle.**—The attachments and anterior surface of this muscle have been dissected with the deep parts on the front of the thigh. Its posterior aspect, its attachment to the linea aspera, and its deep tendinous process to the tubercle above the inner condyle, must now be made plain. It will be noted that this tendon of insertion is strong, and rather more than a quarter of an inch deep, and that it forms a deep boundary of the popliteal space above the joint on the inner side. This muscle is altogether fleshy on its posterior surface; even at its adductor opening for the femoral artery; and the fibres going from the pubic arch seem to be distinct from those connected with the ischial tuberosity. The great sciatic nerve, the perforating arteries, and the hamstring muscles are in relation with this surface of the muscle.

Termination of the Perforating Arteries.—There are usually four perforating arteries. The first appears opposite the lower border of the pectineus and perforates the adductors magnus and brevis. The second is given off about the middle of the adductor brevis, perforates the same muscle, and gives a nutrient branch to the femoral shaft. The third is given off from the profunda below the adductor brevis and pierces the magnus. The fourth or termination of the profunda pierces the magnus near the adductor opening. They come through the great adductor close to the inner side of the femur and pass out through the *external* intermuscular septum and through the short head of the biceps to the vasti, in which they anastomose together, and with the descending branches of the external circumflex artery, with the lower perforating and termination of profunda, and also with the superior articular vessels from the popliteal. The first perforating, being given off above the attachment of the femoral head of the biceps, does not pierce it, but perforates the femoral insertion of the gluteus maximus. The perforating vessels give muscular branches to the hamstrings and cutaneous filaments on the back and outer part of the thigh.

The **Profunda femoris** also gives off *muscular* branches which pierce the great adductor internal to the perforating vessels at some little distance from the femur. There are usually four or five; the highest appearing about five inches from the pelvis, and the others about two inches apart, pierce the adductor magnus in a line with it. They supply more especially the inner hamstrings, particularly the semimembranosus, and anastomose with the superior muscular and inner articular branches of the popliteal.

The Hip Joint. *Dissection.*—This joint should now be dissected, the muscles and any fat and cellular tissue should be removed from the back of the capsular ligament, the attachments of which must be clearly made out. The other dissectors may allow the body to be turned over for ten or fifteen minutes, so that the anterior part of the capsule may be cleaned and its processes defined.

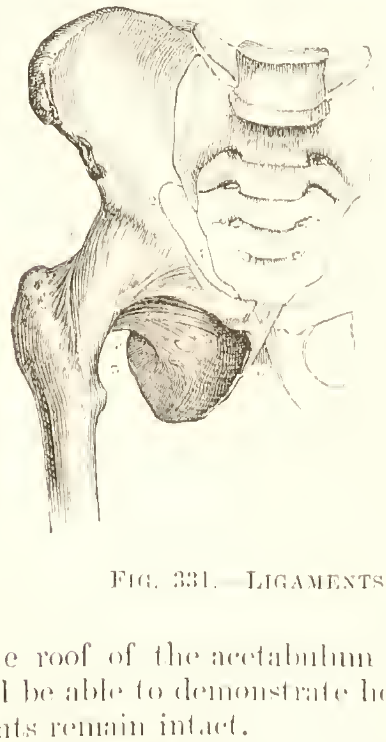
Ligaments.—These are extra- and intra-articular, and although called ligaments they are not the main factors in keeping the joint surfaces in contact. In the hip joint atmospheric pressure plays a most important



a. Ilium.
b. Ischium.
c. Pubes.
d. Femur.
1. Ant. sup. spine.
2. Ant. inf. spine.
3. Pubic tubercle.
4. Ilio-pectineal tubercle.
5. Descending ramus of pubes.
6. Ascending ramus of ischium.
7. Tuber ischii.
8. Small trochanter.
9. Great trochanter.
10. Poupart's lig.
11. Gimbernat's lig.
12. Cut tendon of rectus.
13. Gluteal fascia.
14. Sup. ilio-femoral lig.
15. Ant. ilio-femoral.
16. Pubo-femoral.
17. Part of capsular.
18. Gap between 14 and 15.
19. Obturator lig.
20. Obturator foramen.

FIG. 330.—LIGAMENTS OF LEFT HIP. FRONT VIEW, ONE-THIRD

part in doing this, and is aided by the tonicity of the muscles. Its only articular ligament, viz. the capsular, *assists* in maintaining the apposition of the bones and tending to prevent dislocation, but if air be admitted



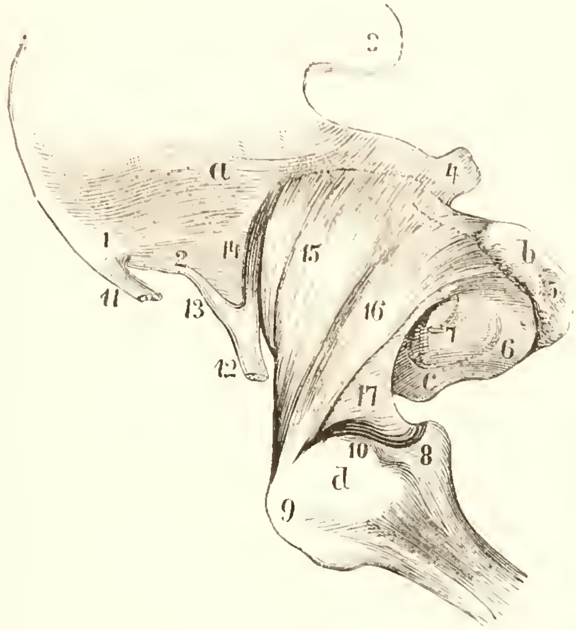
1. Capsule.
2. Its upper attachment.
3. Its lower.
4. Great sacro-sciatic foramen.
5. Obturator externus.
6. Symphysis pubis.

FIG. 331.—LIGAMENTS OF THE RIGHT HIP.

through the roof of the acetabulum by means of a small trephine, the student will be able to demonstrate how easily the bone is displaced while the ligaments remain intact.

Directions.—Before doing this he should, by referring to the wood-

cuts, make himself familiar with the various accessory processes of the capsular ligament; then he may perforate the acetabulum from above, and afterwards should submit the joint to the various movements of which it is capable, and observe the different parts they play in checking or per-



a. Ilium.
b. Ischium.
c. Pubes.
d. Femur.
1. Ant. sup. spine.
2. Ant. inf. spine.
3. Post. inf. spine.
4. Spine of ischium.
5. Tuber ischii.
6. Ascending ramus of ischium.
7. Obturator lig.
8. Trochanter minor.
9. Trochanter major.
10. Post. intertrochanteric line.
11. Poupart's lig.
12. Bifurcated tendon of rectus.
13. Its anterior, and
14. Its posterior attachments.
15. Capsular lig.
16. Ischio-femoral.
17. Circular fibres of capsule.

FIG. 332.—LEFT HIP. POSTERIOR VIEW, ONE-THIRD.

1. Fifth lumbar vertebra.
2. Ilium.
3. Ischium.
4. Pubes.
5. Femur.
6. Ilio-lumbar ligament.
7. Posterior sacro-iliac.
8. Great sacro-sciatic.
9. Oblique sacro-iliac.
10. Small sacro-sciatic.
11. Posterior superficial sacro-coccygeal.
12. Posterior deep sacro-coccygeal
13. Obturator.
14. Symphysis.
15. Posterior part of capsular.

FIG. 333.—PELVIC LIGAMENTS. POSTERIOR VIEW, ONE-THIRD.

mitting them. By turning to the paragraph headed *Movements*, in this section, he will be enabled to verify the description.

By arrangement with the dissector of the abdomen, who will be interested in the observation, the student should carefully trephine or chisel

out a small piece from the roof of the acetabulum in order to observe what has already been stated with regard to the capsule, and also to note how the ligamentum teres is affected with regard to its tension or laxity in the various movements of the joint. He may also try to inject into the joint some warm tallow so as to note if there be any hernial protrusions or projections of the synovial membrane between the layers of the capsule, or whether the synovial membrane of the joint communicates with any of the neighbouring bursæ, more especially with the psoas bursa.

Capsular Ligament.—The capsular ligament is a strong and thick fibrous capsule passing from the margin of the acetabulum to the femoral neck. It is attached *superiorly* to the circumference of the acetabulum, at a short distance from its edge, and by its *inner* part it blends with the outer surface of the cotyloid ligament. Across the notch at the inner side

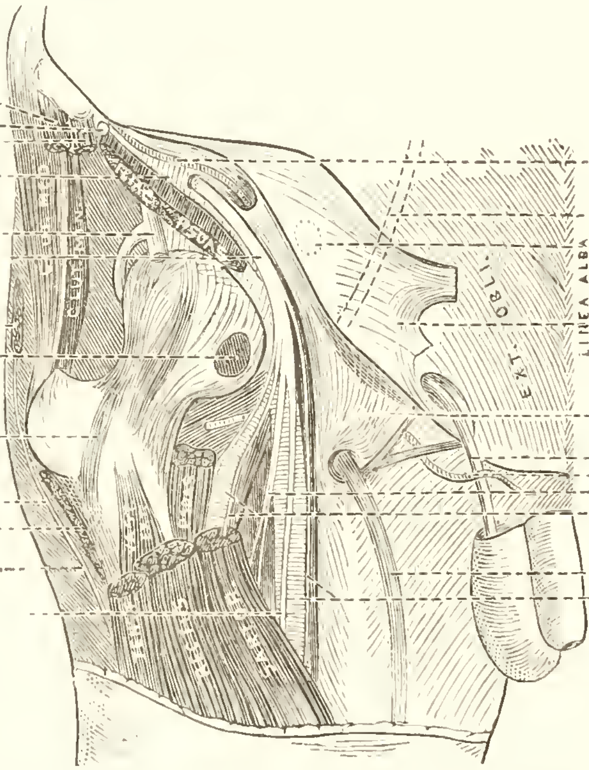


FIG. 331.—SHOWING THE RELATIONS OF THE RIGHT HIP JOINT.

The anterior crural nerve is represented as pulled inwards.

of the acetabular cavity, it is connected transversely with the outer surface of the obturator membrane and front of the upper part of the tuber ischii. *Inferiorly* it is attached around the neck of the femur in front of the anterior intertrochanteric or spiral-line, and to the base of the femoral neck. *Behind* it is thinner and is not attached so low down on the neck. Its *insertion* is from about a finger's breadth from the small trochanter to the middle of the neck of the bone, about half an inch above the posterior intertrochanteric line. At its *upper and posterior* part it is nearer the great trochanter, and passes forwards to blend with the insertion of the thick anterior part. It varies in the arrangement of its fibres, and in its strength on its anterior and posterior aspects. It is considerably thicker and stronger at the *anterior* and *external* parts of the joint where the

greatest resistance is required. *Below* and *posteriorly* it is thin, loose, and longer than in its other parts.

Its external surface is somewhat rough and covered by numerous muscles, being separated in front by a synovial bursa from the psoas and iliacus. This bursa frequently communicates with the joint by a circular aperture. The capsular ligament of the hip differs from that of the shoulder in not being perforated by a tendon, and in being less loose.

Certain portions of the capsular ligament are stronger than others, forming the *accessory bands* of fibres. On the front there is a wide longitudinal layer of fibres, the central thick portion of which is called the *ilio-femoral ligament*, or ligament of Bertin. It extends obliquely across the front of the joint and strengthens it in this situation. It is attached above to the anterior inferior iliac spinous process, and widens below, where it is fixed to the middle of the anterior intertrochanteric line. It is sometimes bifurcated at its lower end, an arrangement which Bigelow looks on as usual, and he has described it under the name of the *Y Ligament*. This *ilio-femoral* ligament is the strongest in the body, and prevents *over-extension* of the joint. It is also the main means in keeping up the erect position without tiring the extensor muscles, and the action of the gluteal muscles is counterbalanced by its tension. The femur being fixed, it will considerably assist in sustaining the pelvis on the femoral head. The *outer* portion of the *anterior* surface of the capsular ligament is also thickened, and extends from half an inch below and outside the anterior inferior iliac spinous process, opposite the outer head of the rectus, to the fore and upper part of the great trochanter and neck of the femur. This portion of the capsular ligament checks *adduction* of the femur. It is called the *ilio-trochanteric* band. The *inner* portion of the *front* of the capsule is also thickened, and is called the *pubo-femoral* band; it is fixed *above* to the prominent portion of the pubes internal to the acetabulum, and *below* is attached to the rough surface at the anterior part of the femoral neck, in front of, and on a level with, the lesser trochanter. This portion limits *adduction* of the joint.

The capsule at its *posterior* part has a transverse band of fibres about the width of the index-finger which arches over and surrounds the neck of the bone. This band is fixed by its lower edge to the cervix femoris by a thin layer of ligamentous tissue and synovial membrane. To its *upper* edge are attached the longitudinal posterior fibres of the capsule. This arrangement obviates that restriction of the *to and fro* movements of the joint, which would occur if the longitudinal fibres were attached to the posterior part of the neck of the femur instead of being inserted into the transverse band of the capsule.

Relations.—In cleaning the capsular ligament the student must have noticed the more immediate muscular relations of the joint. In *front* and *below* are the psoas and iliacus, separated by a bursa; *above*, in *front*, and to the *inner* side are the pectineus and obturator externus; the short-head of the rectus is above, and *above* and *behind* are the long-head of the rectus and the gluteus minimus, the latter closely adherent to the capsule. The obturator internus and gemelli, the tendon of the obturator externus, the quadratus femoris, and the pyriformis are *behind*. The femoral artery runs over the *front* of the joint a little *internal* to the femoral head, being separated by muscular fibres. The great sciatic nerve runs *pos-*

terior to the joint, over the quadratus femoris, between the tuber ischii and the great trochanter.

Arteries and Nerves.—The *arterial* supply of this joint comes from the sciatic, gluteal, internal circumflex, and obturator, its *nerves* from the

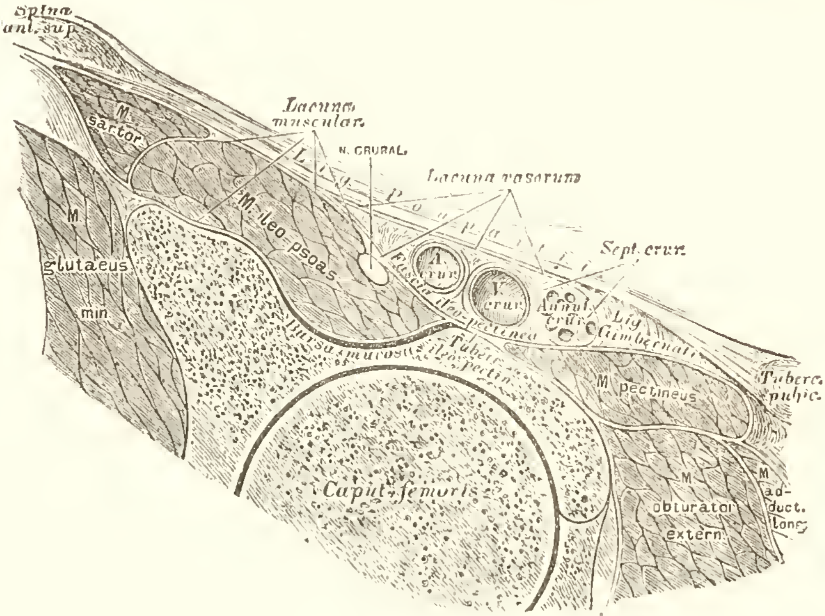
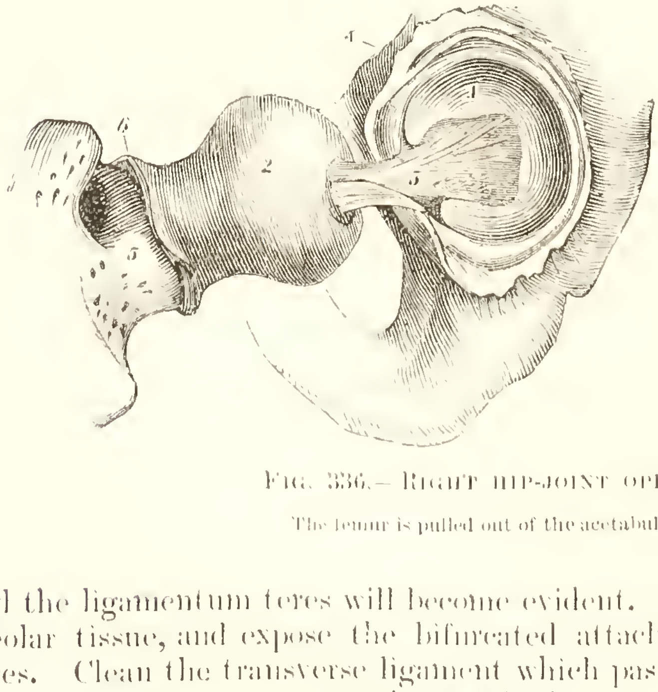


Fig. 335.—Vertical section through right hip-joint.

great sciatic, obturator, and accessory obturator, when present, and it also receives articular branches from the sacral plexus.

Dissection.—Divide the capsular ligament about half an inch from the acetabulum. Displace the head of the femur, then the cotyloid ligament



1. Cotyloid cavity.
2. Head of femur.
3. Lig. teres.
4. Upper part of capsule, reflected.
5. Neck of femur.
6. Insertion of capsule.

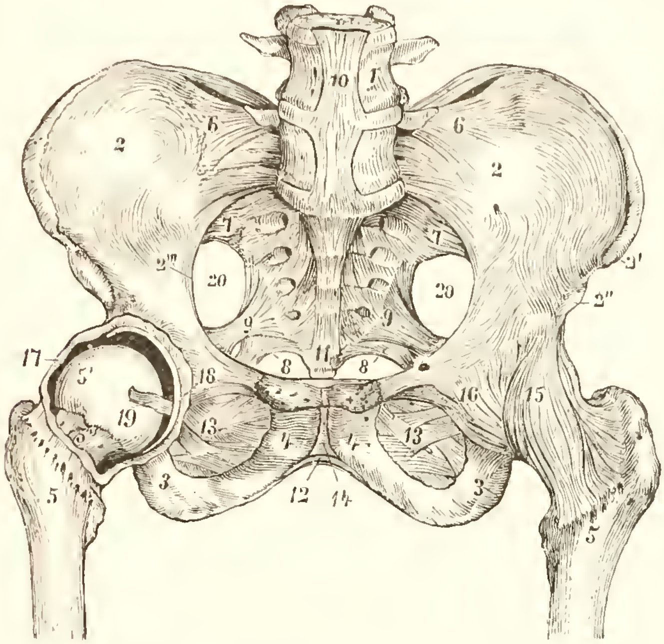
Fig. 336.—Right hip-joint opened.

The femur is pulled out of the acetabulum.

and the ligamentum teres will become evident. Remove the synovial and areolar tissue, and expose the bifurcated attachment of the ligamentum teres. Clean the transverse ligament which passes over the notch.

The **Ligamentum teres,** or *interarticular,* or *round* ligament, is a trian-

gular band of fibres about an inch in length, and is attached by its *apex*, which is roundish, to a depression slightly *behind* and *below* the centre of the femoral head. Its broad *base* is flattened, and divides into two bands of fibres which are attached thus: the upper or anterior piece, called the

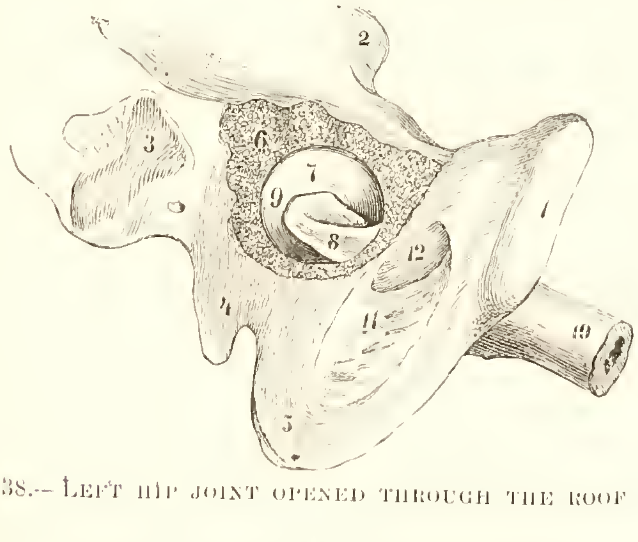


1. Four lumbar vertebra.
2. Ilium.
2'. Ant. sup. spine.
2''. Ant. inf. spine.
3. Ischium.
4. Pubes.
5. Femur.
5'. Head of femur.
5''. Femoral neck.
6. Ilio-lumbar lig.
7. Ant. sacro-iliac.
8. Great sciatic.
9. Lesser sciatic.
10. Ant. common lig.
11. Ant. sacro-coccygeal.
12. Subpubic lig.
13. Obturator lig.
14. Symphysis pubis.
15. Ilio-femoral.
16. Pubo-femoral.
17. Capsular.
18. Cotyloid.
19. Lig. teres.
20. Great sacro-sciatic foramen.
2'''. Ilio-pectineal line.

FIG. 337.—PELVIC LIGAMENTS. ANTERIOR VIEW, ONE-FOURTH.

The right hip-joint is opened and the femur rotated out.

pubic portion of the ligament, blends with the transverse ligament and is fixed to the pubic edge of the notch; the posterior lower piece, the *ischial portion*, is inserted behind the transverse ligament into the ischial portion of the cotyloid notch. The strength and thickness of this ligament are



1. Symphysis.
2. Ant. inf. spine.
3. Auricular surface.
4. Ischial spine.
5. Tuber ischii.
6. Section of innominate bone.
7. Head of femur.
8. Lig. teres.
9. Depression for lig. teres.
10. Shaft of femur.
11. Obturator membrane.
12. „ foramen.

FIG. 338.—LEFT HIP JOINT OPENED THROUGH THE ROOF OF THE ACETABULUM.

variable. It is surrounded by a tubular process of the synovial membrane; this may exist even when the ligament is absent. The round ligament checks *external rotation* and *adduction* in the flexed position. It con-

sequently tends to prevent dislocation forwards and outwards. Mr. Savory, in the *Lancet* of May 23, 1874, says that the ligamentum teres is always tense when standing upright, and is further tightened in standing on one leg, and consequently is of opinion that its main function is to support and distribute the body weight over the whole surface of the acetabulum and head of the femur. Some anatomists say that the ligament is lax when the limb is extended, as then the innominate and femoral attachments are near each other. If the femur be *adducted* the *ischial* portion becomes tense because the femoral head is raised. If the joint be *flexed* the ligament becomes tense, as then the femoral insertion is removed from the acetabular; and the ligament will be most stretched if, in the *flexed* condition, the femur be *adducted* or *rotated out*.

Dissection.—Divide the ligamentum teres so that the cavity of the acetabulum and the cotyloid and transverse ligaments may be studied.

The **Cotyloid ligament** is a narrow fibro-cartilaginous band, which is attached by its *base* to the acetabular margin, the inequalities of which it fills up, and is prolonged across the notch on its inner and lower side (the ischio-pubic notch), and forms the superficial part of the transverse ligament. It is thinner at its free margin or apex, where it embraces the head of the femur. Its outer surface is in contact with the capsular ligament, and its inner surface is inclined inwards and narrows and deepens the acetabulum.

It is much thicker *above* than behind, and *below* than in front, and its fibres are close and compact, and interlace in various directions. The inner part of the capsular ligament often blends with the outer part of the cotyloid.

The **Transverse ligament** is a strongish narrow band of fibres which crosses the notch at the lower part of the acetabulum (ischio-pubic), and converts it into a foramen. It is continuous at the margins of the notch with the cotyloid, and its *superficial* part, which is mostly distinct, is a continuation of the cotyloid over the notch. The *deeper* fibres are special to the ligament. Beneath it the nutrient vessels of the joint pass in and out. The fatty tissue in the joint communicates beneath this ligament with the areolar tissue outside the joint, so that pus formed within the joint may pass down and inwards to the thigh and *vice versa*.

The **Joint Surfaces.**—It will now be clear that the hip joint is an enarthrodial, or ball-and-socket joint, being the largest and most perfect of its kind in the human body. It is formed by the head of the femur fitting into the cavity of the acetabulum.

The *Acetabulum* is coated with cartilage over the greater part of its surface excepting where the interarticular mass of fat is lodged (the so-called gland of Havers), and opposite the ischio-pubic notch. The articular surface of the acetabulum is deep above, but narrows towards the notch. The head of the femur, or rather the cartilage covering its head, is in contact with the acetabular cartilage and the interarticular adipose mass. A depression a little behind and below its centre will be noticed on the head of the femur, to this the round ligament is attached; on that part of the acetabulum uncovered by cartilage is a mass of vascular fatty tissue which is thicker near the margin of the cartilage than near the transverse ligament, and which acts as a buffer preventing concussion of the head of the femur against the thin roof of the acetabulum. This is the so-called gland of Havers.

Synovial Membrane.—The synovial membrane of this joint is extensive, and like all serous membranes is a closed sac. It lines the capsular ligament and invests the others. If we commence at the margin of the acetabulum it will be seen to be reflected on the inner surfaces of the capsular, and reflected along the neck and over the head of the femur, along the ligamentum teres to the bottom of the acetabulum, and then along the inner side of the cotyloid ligament, over its outer side to the margin of the acetabulum again.

Movements of the Joint.—These are: *flexion*, *extension*, *abduction*,

FIG. 339.—VERTICAL TRANSVERSE SECTION THROUGH RIGHT HIP JOINT.

A. Internal iliac fossa cut.

adduction, *circumduction*, *and rotation*. *Flexion* is much greater than extension, and is only limited by the contact of the thigh and abdominal wall. The *posterior* part of the capsule and the ilio-trochanteric band are rendered tight. The *flexors* are the psoas and iliacus, assisted by the sartorius and rectus. In *extension* the *anterior* part of the capsule, especially its ilio- and pubo-femoral bands, are made tense. *Extension* is mainly produced by the hamstring muscles, aided by the gluteus maximus. During these to and fro movements, the femoral head rotates round a line which is on a plane with the axis of the head and neck, and the more

complete mechanical arrangements of this joint, as compared with that of the shoulder, tend considerably to prevent any dislocation. The cotyloid ligament so closely embraces the head of the femur, that it tends considerably to prevent luxation, even if the capsule be divided. If the femur be

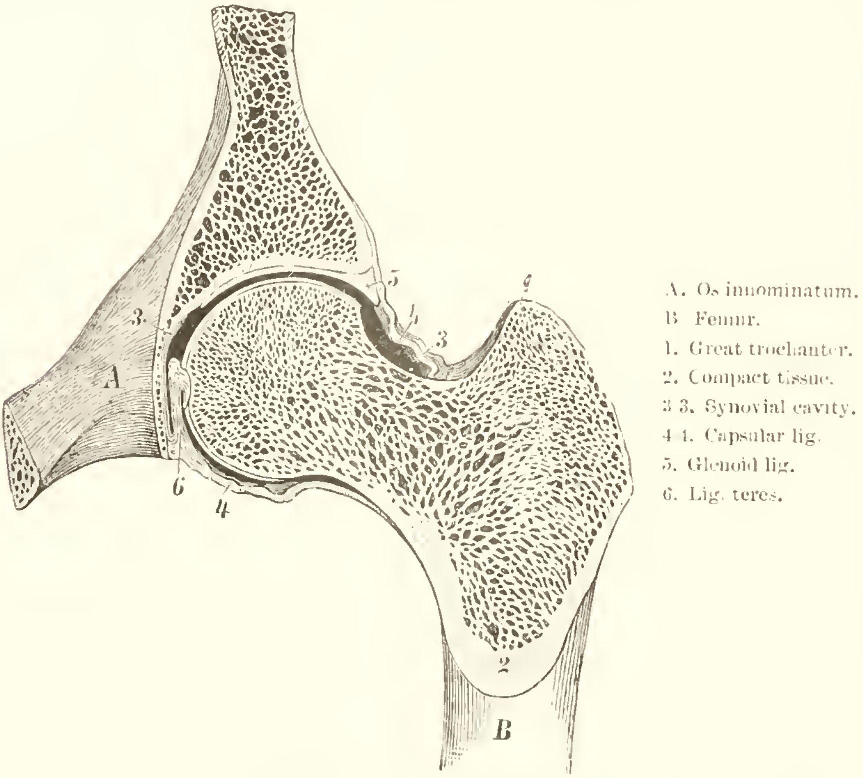


FIG. 340.—TRANSVERSE VERTICAL SECTION THROUGH LEFT HIP JOINT.

abducted, that is removed from the mid-line, the *pubo-femoral* process and *inner* portion of the capsular ligament are put on the stretch. *Abduction* is more extensive than *adduction*, because in the latter move-

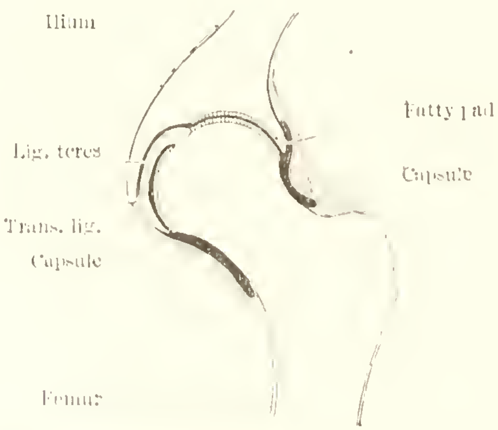


FIG. 341.—VERTICAL TRANSVERSE SECTION THROUGH LEFT HIP.

ment the thigh meets its fellow, but if carried in front of it the amount of adduction is much increased. In both ab- and adduction the shaft and head of the femur move in opposite directions. In *abduction* the head

descends *down* and *in*, and the greater part of its articular surface projects beyond the acetabulum. This movement is produced by the gluteus medius and minimus and tensor fasciæ femoris, and is limited by the *inner* and lower parts of the capsule, and by the meeting of the great trochanter and the outer part of the acetabular rim. In *adduction* the head gradually rises into its socket, and when the limb reaches the straight position is placed on the deepest part of the cavity, but if this movement be continued the head will descend *down* and *out*, and the *outer* part of the capsule and *ilio-trochanteric* band will be tightened. Extreme adduction is limited by the meeting of the under surface of the femoral neck with the inner margin of the brim of the acetabulum. The adductors, gracilis, and pectineus produce this movement.

If either abduction or adduction be extreme and sudden, dislocation is likely to take place and will be assisted by the margin of the cotyloid cavity acting as a fulcrum, through which the force applied to the femoral shaft will lift the head of the femur out of the acetabulum. After reducing a dislocation at the hip, the knees should be fastened together, as then the head of the femur is securely placed in the deepest part of the acetabulum.

Circumduction consists in the combination of the four angular motions, viz. flexion, extension, abduction, and adduction. The limb then describes a cone whose *apex* is at the junction of the neck and shaft of the femur, and whose *base* is at its periphery. In the shoulder it is, as has been seen, much more free than in the hip, partly because of the greater laxity of its capsule, but mainly because of the very slight angle between the neck and shaft.

Rotation may be either internal or external. In the former the big toe is turned in; and in the latter, which is the more extensive of the two, it is everted.

In *external rotation* the femoral head turns forward and outward, and the trochanter major is brought nearer the tuber ischii. The shaft of the femur moves round a line on its inner side which passes from the hip to the inner condyle, the *anterior* part of the capsule is *tightened* and the hinder loosened.

The *external rotators* are the pyriformis, obturator internus and gemelli, quadratus femoris, gluteus maximus, posterior fibres of gluteus minimus, and the psoas and iliacus, which, in flexing the thigh, rotate it outwards also.

In *internal rotation*, the femoral head glides horizontally backwards, the great trochanter passing forwards, the shaft of the bone revolving round a line on its inner side. The *posterior* part of the capsule is *stretched* and the anterior relaxed. If the neck of the femur be fractured rotatory movements are lost. The amount of rotation is directly proportional to the length of the femoral neck. The *internal rotators* are the gluteus medius and anterior fibres of the minimus.

The angle formed by the neck of the femur with its shaft serves to give greater security to the joint in its various movements, as by this arrangement the greater part of the femoral head is kept in its socket. It also allows of greater contact between the head of the femur and the acetabulum during progression, and gives room for the big bony process, the trochanter major, by means of which greater length of leverage is

given to the rotator muscles which are attached to it. Were it not for this angle, the important rotatory movements of the joint would be considerably hampered, and the space necessary on the inner side of the femur for the strong adductors would be much diminished.

THE BACK OF THE LEG.

Surface Markings.—The *bony prominences* of the leg are formed by the tibia and fibula. The former bone is on the inner side, is subcutaneous on that side, and is limited in front and behind by sharpish borders. At its upper and anterior part is a prominent tubercle into which is inserted the anterior ligament of the knee, or ligamentum patellæ. Above this may be felt the outer and inner tuberosities of the head of the tibia, and a tubercle on the outer side of the tibial head. Below, this bone ends on the inner side of the ankle, in the projection called the internal malleolus. On the outer side of the leg, at its upper half, the fibula is covered by the peronei muscles, but is subcutaneous in the lower half, where it can easily be felt. It lies on the outer and back part of the tibia, nearly on a level with its anterior tubercle. Just below the outer side of the knee the head of the fibula may readily be felt, and its lower end forms the projection called the 'external malleolus,' which is on a lower level than the inner. If the foot be extended, the head of the astragalus may be felt below the tibia.

The *muscular* markings are the prominence of the calf which is formed by the gastrocnemius and soleus. The conjoined tendons of these muscles form the tendo-Achillis, which can easily be seen and felt along nearly the lower half of the leg as far as the os calcis. Between the inner border of the tendon and the inner edge of the tibia, but rather nearer the former, is situated the lower part of the posterior tibial artery. In front and to the outer side between the bones of the leg will be felt the extensor muscles of the toes, and flexors of the foot. Between these, lying deeply, are the anterior tibial vessels and nerve. A line from the inner side of the head of the fibula to the middle of the ankle will indicate the position of the anterior tibial artery; whereas, on the back of the limb a line from about the middle of the upper part of the calf to the mid-space between the inner malleolus and tendo-Achillis, will indicate the position of the posterior tibial artery.

The *Foot.*—The *surface markings* on the foot are the following. Behind is the tuberosity of the os calcis, and about an inch in front of the internal malleolus is the tubercle of the scaphoid; and about an inch and a half in front of this is a slight depression, which corresponds to the articulation between the internal cuneiform and the metatarsal bone of the great toe. About an inch below the apex of the internal malleolus is the projection of the sustentaculum tali of the os calcis; and beneath the metatarso-phalangeal articulation may be felt the sesamoid bones of the great toe. On the outer border of the foot the student should feel the external tuberosity of the os calcis, the peroneal tubercle of the same bone an inch below the apex of the outer malleolus, and about the centre of this border the tarsal end of the fifth metatarsal bone can clearly be dis-

tinguished. To ascertain the position of the dorsal artery of the foot, a line may be drawn from the centre of the ankle to the interval between the first and second metatarsal bones.

In the sole the student may feel the central strongest piece of the

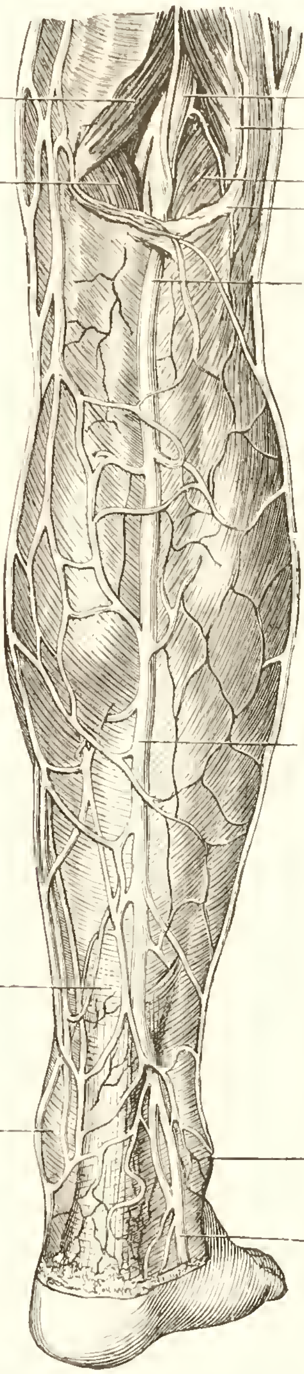


FIG. 312.—RIGHT EXTERNAL SAPHENA VEIN.

plantar fascia, by fixing the heel and extending the foot. This often has to be divided in some forms of club feet.

Dissection.—The limb being placed on its front, let the foot hang over the side of the table, and put the calf muscles on the stretch by fastening the foot in the flexed position; make an incision along the middle of the

leg from the popliteal region to the lower border of the os calcis; reflect the skin as far as the outer border of the fibula and the inner of the tibia. In the subcutaneous fat will be found, on the inner side and close to the tibia, some branches of the internal cutaneous nerve near the knee, and the internal saphenous vein and nerve passing down in front of the inner malleolus. In the middle of the leg is the external saphenous vein, accompanied by the termination of the small sciatic nerve above the

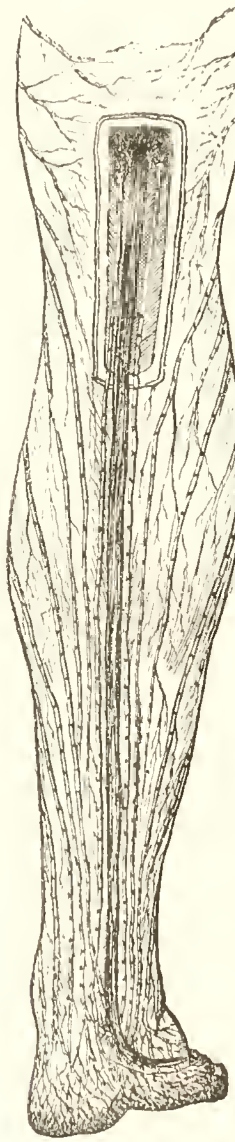


FIG. 313.—LYMPHATICS OF THE BACK OF THE LEG AND SOLE. RIGHT SIDE.

A window has been cut in the popliteal space to show the junction of the superficial with the deep at the popliteal glands. The external saphena vein is shown.

middle of the leg, and the external saphenous nerve below. Externally, in the upper third will be found some twigs of the external popliteal nerve.

Superficial Vessels and Nerves.—The **internal saphenous vein** begins in an arch on the dorsum of the foot, passes in front of the inner malleolus, then behind the inner border of the tibia, and reaches the thigh behind

the internal condyle. It receives several superficial veins and deep branches from the tibial veins. The valves in it vary from two to six, and are more numerous in the thigh than in the leg. In the foot it communicates with the internal plantar; in the leg with the anterior tibial veins,

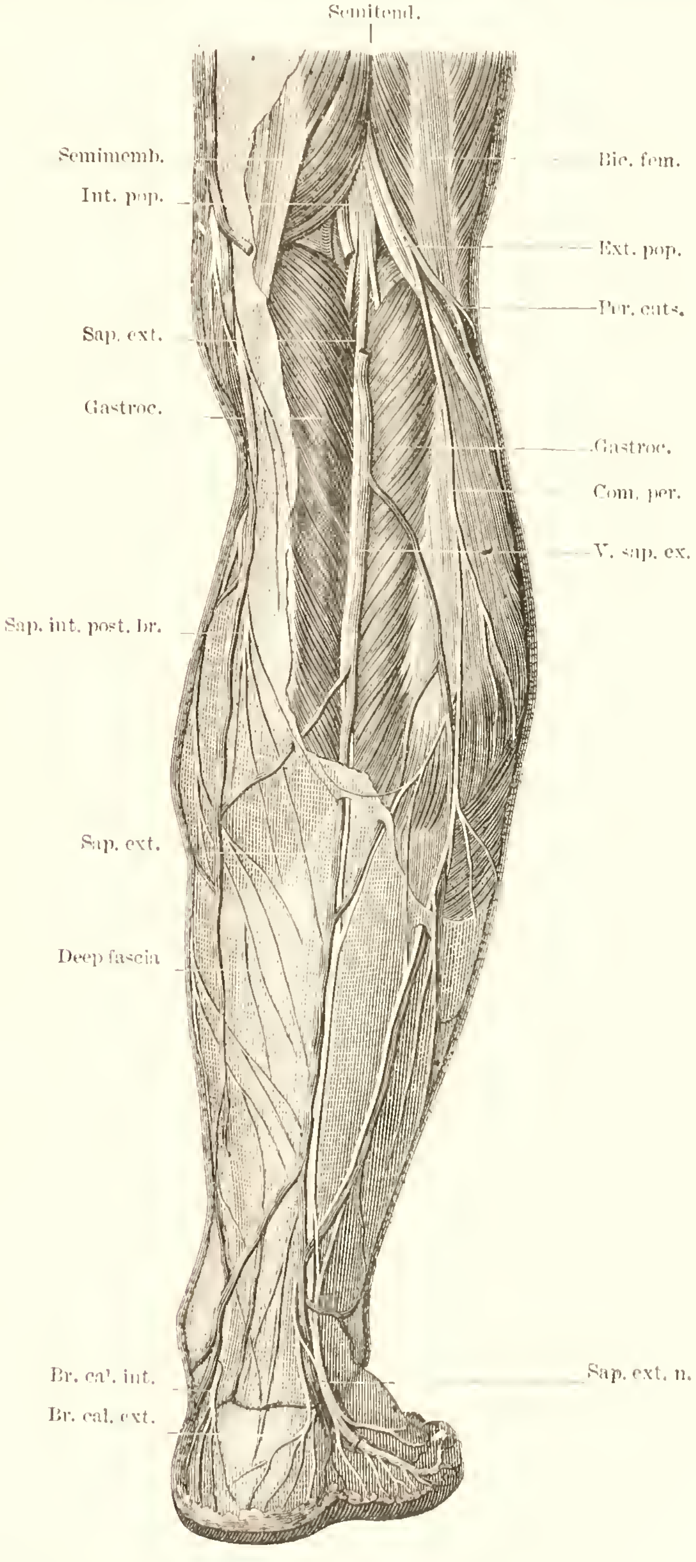


FIG. 344.—BRANCHES OF RIGHT EXTERNAL AND INTERNAL SAPHENOUS NERVES.

Some cutaneous veins are shown. The internal saphena vein is seen with the nerve.

and with the posterior tibial by branches which pierce the tibial origin of the soleus.

The **External Saphenous vein** commences in an arch at the outer side of the dorsum of the foot, and passes below and behind the external malleolus and along the outer border of the leg. It then runs along the back of the leg to the tendo-Achillis, which it crosses at a right angle, to gain the mid-line of the posterior part of the leg, and in the lower part of the popliteal space it pierces the deep fascia to end in the popliteal vein. Between the heads of the gastrocnemius it receives numerous large branches, also some about the heel, and others on the back of the leg. It is joined by the internal saphenous vein, and communicates with the deep veins on the dorsum of the foot, and with those behind the outer malleolus. It has usually only two valves, of which one is constant, and is near its termination in the popliteal vein. Cutaneous arteries from muscular branches of the posterior tibial, and peroneal, accompany the superficial veins and nerves.

The *superficial lymphatics* commence in plexuses from the toes, sole, heel, and sides of the foot, and join lymphatic trunks which run parallel with the external saphena vein. The outer and inner ones course along the thigh to the inguinal glands, but several of the middle set pierce the deep fascia to empty themselves into the popliteal glands.

Cutaneous Nerves.—These are continuations of branches which have partly been examined, viz. the small sciatic branches of the internal and external cutaneous, filaments of the anterior crural, the internal and external saphenous nerves, and cutaneous filaments of the external popliteal.

The *internal* or *long saphenous nerve* accompanies the internal saphenous vein, passing behind the inner border of the tibia, and at the lower third of the leg it divides into two branches, the *posterior* of which runs along the tibial margin ending at the inner ankle. The *anterior* branch passes in front to the ankle and supplies the skin along the inner side of the foot as far as below the great toe. *Lateral cutaneous* offsets are given off from this nerve in the leg, the outer of which pass to the anterior aspect of the tibia and join the internal cutaneous.

The *external* or *short saphenous nerve* is usually a branch of the internal popliteal, and descends between the heads of the gastrocnemius along the back of the leg, and pierces the deep fascia about its middle. It accompanies the external saphenous vein behind and below the external malleolus, supplying the outer side of the foot and of the little toe. Just after piercing the deep fascia it receives a communicating branch (*communicans peronei vel fibularis*) from the external popliteal. At the outer side of the tendo-Achillis, near the heel, it gives long and large filaments to the integuments and is joined to the small sciatic, and on the dorsum of the foot it communicates with the musculo-cutaneous nerve.

Cutaneous Branches of the External Popliteal.—These are usually two or three, and supply the skin of the back and outer side of the leg to a little below its middle. One branch, larger than the others (the *communicating peroneal*), is given off near the head of the fibula, crosses the external head of the gastrocnemius, and joins the external saphenous just after that nerve pierces the deep fascia. Occasionally this nerve is separate as far as the heel. One or two filaments of the external popliteal supply the skin of the front and outer side of the leg in its upper half.

The *small sciatic nerve* pierces the deep fascia at the lower part of the popliteal space, and accompanies the external saphenous vein below the middle of the leg, where it communicates with the external saphenous nerve.

Branches of the Internal Cutaneous.—The inner branch of this nerve

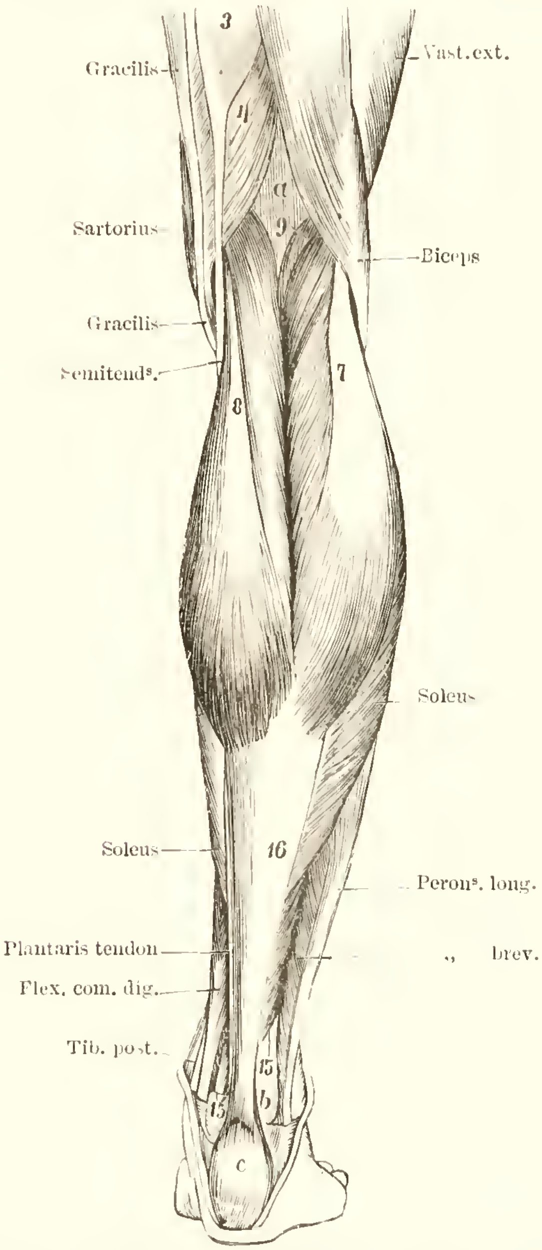


FIG. 345.—SUPERFICIAL MUSCLES OF BACK OF RIGHT LEG.

a. Pop^l. space. *b.* Ext^l. malleolus. *c.* Os calcis. 4. Semimemb^s. 7, 8. Gastroc^s. 9. Plantaris. 15 15. Flex. long. hall. 16. Tendo-Achillis.

passes down on the inner side of the leg as far as its middle, lying behind the internal saphenous nerve with which it communicates.

Dissection.—Remove the superficial fatty layer and reflect the vessels and nerves, the deep fascia will then be exposed.

The *deep fascia at the back of the leg* invests the muscles, and on the outer side gives off two strong intermuscular septa which enclose the

peronei and separate them from the muscles on the anterior and posterior tibial regions, and after giving several smaller processes which enclose the muscles individually, gives off a broad *transverse intermuscular septum* which separates the superficial from the deep muscles. Laterally it is continued to the posterior margins of the tibia and fibula. Above, over the popliteus, it is strong and receives the expansion from the semi-membranosus. In the middle of the leg it is thinner, but behind the internal malleolus it is much thickened and covers the tendons of the tibialis posticus, flexor longus hallucis and flexor longus digitorum, enclosing them in osseo-fibrous sheaths between the heel and ankle. It also covers the posterior tibial vessels and nerve, and blends with the internal annular

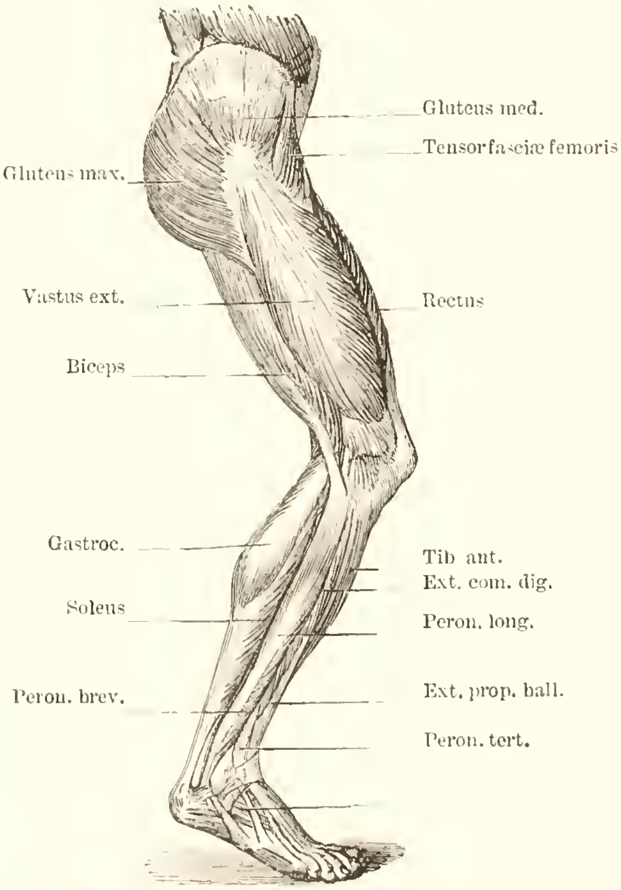


FIG. 346.—MUSCLES OF RIGHT THIGH AND LEG. EXTERNAL VIEW.

ligament. This deep fascia is pierced by the cutaneous nerves and veins, which pass through it from the deep to the superficial vessels. Reflect this fascia by an incision along the centre of the leg, and put on the stretch the fibres of the gastrocnemius, which is to be cleaned.

Superficial Muscles.—These are the gastrocnemius, soleus, and plantaris. The last-named is very small, having a very long tendon; the other two are large and fleshy, and end in a tendon common to both, the *tendo-Achillis.*

The **Gastrocnemius** is the most superficial muscle, and arises by two heads, the inner of which is the larger, through two flat strong tendons from the back and upper part of the condyles. The *inner layer* and more

posterior head *arises* from a depression at the upper and back part of the *inner* condyle, behind the insertion of the abductor magnus tendon, and by fleshy fibres from the lower part of the inner bifurcation of the linea aspera. The *outer head arises* from the upper and outer part of the external condyle, above the attachment of the popliteus. This muscle is tendinous along the middle. Each tendon expands into an aponeurosis which covers the posterior surface of that part of the muscle pertaining to it. The aponeurosis covering the inner head is longer and thicker than

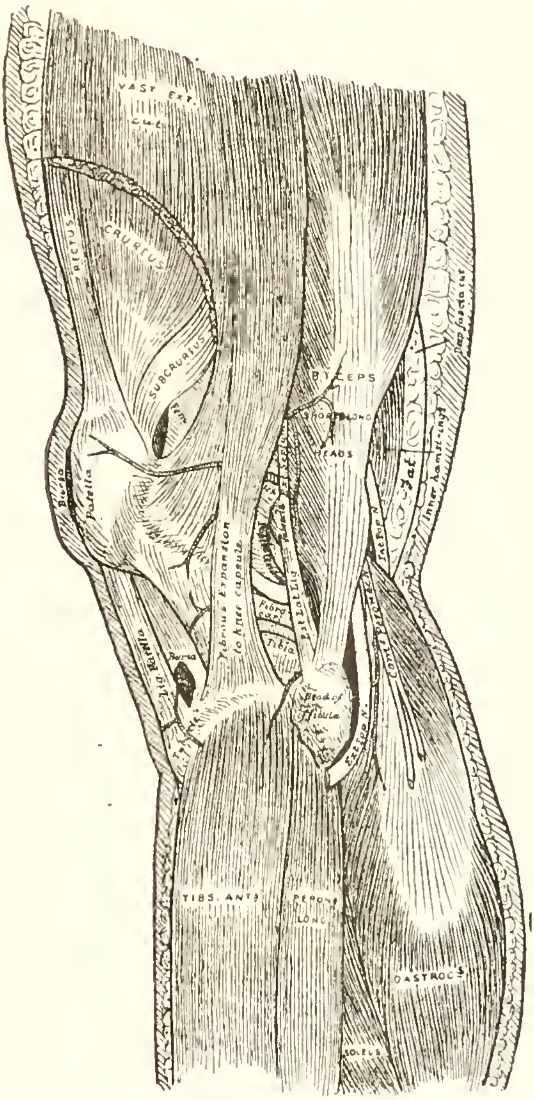
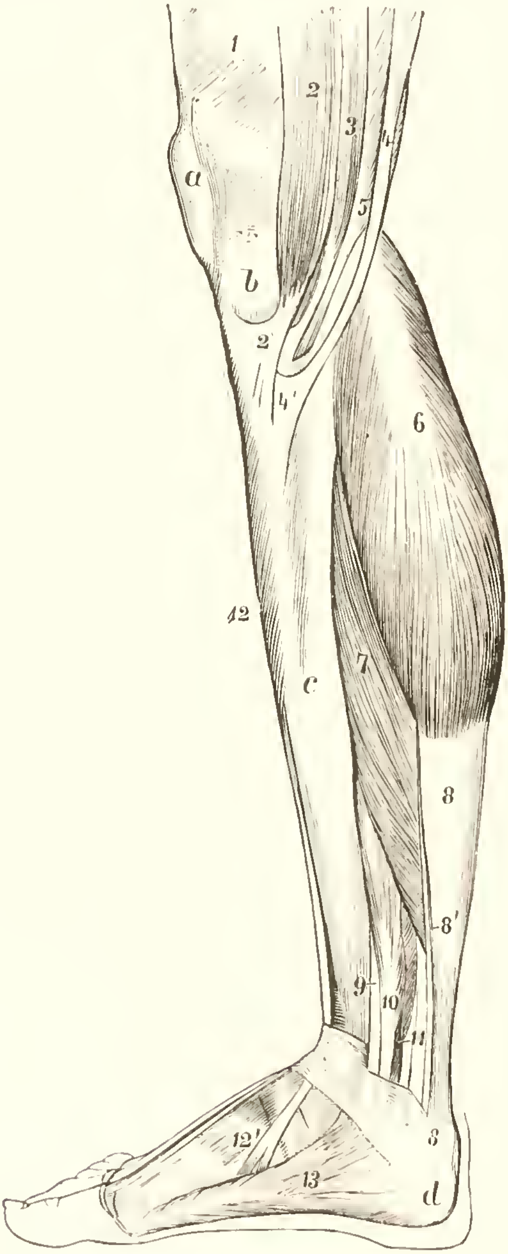


FIG. 317.—SUPERFICIAL DISSECTION OF OUTER SIDE OF LEFT KNEE.

that investing the outer. Muscular fibres arise from the anterior surface of these expansions. The fibres in the mid-line, corresponding to the portions of muscle arising from the bifurcations of the linea aspera, unite along a median, thin aponeurosis, below. The remaining fibres converge to the posterior aspect of an aponeurosis which extends on the front of the muscle, and this, gradually protracting, joins with the tendon of the soleus, forming the *tendo-Achillis*, which will be presently dissected.

Relations.—Superficially with the deep fascia of the leg which sepa-

rates it from the cutaneous vessels and nerves; *deeply* with the soleus, popliteus, plantaris, popliteal vessels, internal popliteal nerve, and posterior ligament of the knee. The heads of this muscle help to form the lateral boundaries of the popliteal space *below the knee.* The fleshy inner head descends lower than the outer. Underneath it is a synovial bursa which sometimes communicates with the knee joint. The tendon of the outer



a. Patella.
b. Tibial tubercle.
c. Crest of tibia.
d. Heel.
1. Vast. int.
2 2'. Sartorius.
3. Gracilis.
4 4'. Semitend.
5. Semimemb.
6. Gastroc.
7. Soleus.
8. Tend.-Achillis.
8'. Tendon of plantaris.
9. Tendon of tib. post.
10. Flex. com. dig.
11. Flex. long. hallucis.
12 12'. Tib. ant.
13. Abd. hall.

FIG. 318.—INNER VIEW OF SUPERFICIAL MUSCLES OF RIGHT LEG. ONE-FIFTH.

head contains a sesamoid fibro-cartilage, which rarely becomes bony, and sometimes one is found in the tendon of the inner head.

Actions.—It extends the ankle pointing the toes, and if the feet be on the ground it can raise the os calcis, and the body weight, as in walking, running, or standing upon the toes. Acting from below it flexes the knee joint, being assisted by the popliteus.

Nerve.—It is supplied by the internal popliteal.

Varieties.—This muscle is sometimes joined by a band of muscular fibres, which takes origin separately from the femur above one of the condyles—this has been seen to pass in some cases between the artery and vein.

Dissection.—Divide the gastrocnemius near its origin, and the vessels and nerves to it; reflect it, and clean the following muscles.

The **Plantaris** is very small, is placed between the gastrocnemius and soleus, and is noteworthy in having the longest tendon in the body. If this be stretched laterally, it assumes the appearance of a ribbon. It has a fusiform belly about two inches in length and three quarters of an inch wide, and *arises* from the lower part of the outer bifurcation of the linea aspera and from the ligamentum posticum Winslowii. Its slender tendon passes obliquely between the two calf muscles to the inner border of the tendo-Achillis, and is inserted with it into the posterior part of the os calcis, or into the fascia of the leg, or into the internal annular ligament.

Varieties.—It is often absent, and occasionally is double. In man it is rudimentary, but in some of the lower animals it exists as a large muscle and is *inserted* into the plantar fascia, of which it is a tensor, or passes forward deeply in the sole as a part of the toe flexors. It may be imbedded in the tendo-Achillis.

Action.—It assists the gastrocnemius to extend the foot if it be not fixed, and to flex the knee if the foot be fixed.

Nerve.—The internal popliteal.

Soleus.—The **Soleus** is a large flat muscle, and has been named from its supposed resemblance to a sole fish. It *arises* by tendinous fibres from the back of the head of the fibula, and the upper half or third of the posterior and internal surfaces of its shaft; from the oblique line of the tibia and from the middle third of its internal border. Some fibres also come from the tendinous arch which passes between the tibial and fibular origins of the muscle, and beneath this the posterior tibial vessels and nerves pass. The fibres pass back to an aponeurosis on the posterior surface of the muscle, and this becoming thicker and narrower, joins the tendon of the gastrocnemius to form the *tendo-Achillis.* The tibial origin of this muscle is pierced by veins from the posterior tibial passing to the internal saphenous.

Relations.—*Superficially* with the gastrocnemius and plantaris, *deeply* with the deep muscular layer and posterior tibial vessels and nerve, from which it is separated by the deep intermuscular fascia of the leg.

The **Tendo-Achillis** is the common tendon of the gastrocnemius and soleus, and is the strongest and thickest tendon in the body. It is about six inches long and about three wide at its upper part. It begins about the middle of the leg, being formed by the union of the aponeuroses of the two preceding muscles. It receives fleshy fibres on its anterior surface nearly to the lower end. It is narrowest about an inch and a half above its insertion and expands a little before it is *inserted* into the lower half of the posterior tuberosity of the os calcis, having a bursa between it and the upper part of the tuberosity.

Relations.—*Superficial to the tendon* are the skin and fasciæ, *deeply*, it is separated from the tendons of the deeper muscles and vessels by a considerable interval, which contains vascular, areolar, and fatty tissue.

Along its *inner border* is the tendon of the plantaris, and along its *outer* are the external saphenous vein and nerve which are *superficial* to it. The fleshy part of the muscle has the plantaris, gastrocnemius, fasciæ, and skin *behind* it, and in *front* of it are the flexor longus hallucis, flexor longus digitorum, tibialis posticus, and posterior tibial vessels and nerve, which latter are separated from it by the deep transverse aponeurosis.

Action.—The soleus extends the ankle pointing the toes, and if the latter rests on the ground it can raise the heel. The tendon is sometimes ruptured in sudden powerful contractions of both muscles. Acting from

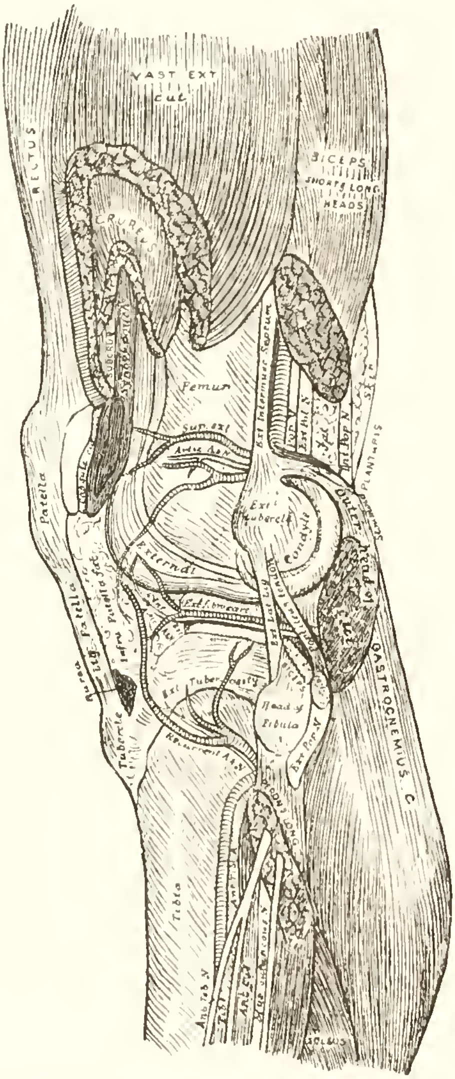


FIG. 349.—DEEP DISSECTION OF OUTER SIDE OF LEFT KNEE.

below, it steadies the leg upon the foot, and prevents the body from falling forwards. On rising from stooping, it will draw back the bones of the leg into a vertical position over the foot.

Nerve.—The internal popliteal.

Varieties.—An accessory portion is sometimes found in connection with its inner and lower part; this sometimes has a tendon which is separately inserted into the os calcis, but generally it is attached to the inner side of the tendo-Achillis.

Dissection.—Separate the soleus from the bones of the leg, divide the vessels and nerves entering it, and be careful of the thin transverse layer of fascia separating the superficial from the deep muscles. Reflect or remove the superficial muscles, and examine the bursa in front of the tendo-Achillis at its insertion into the os calcis. Clean the internal annular ligament, looking for the plantar cutaneous nerve which pierces it.

The *Deep Intermuscular Fascia or Septum.*—This layer is attached to the posterior margins of the tibia and fibula, and binds down the deep muscular layer. Over the popliteus it is thick, and receives an expansion from the semimembranosus, but beneath the soleus it is indistinct and thin. Near the inner malleolus where it covers the tendons and vessels, it is much stronger and has some transverse fibres. Between the heel and inner ankle it blends with the internal annular ligament.

Dissection.—Reflect this fascia by a longitudinal incision, clean the posterior tibial vessels and nerve and the three deep muscles, and after having made out the attachments of the latter, throw outwards and partly divide the flexor longus pollicis to trace the peroneal artery in its substance and to follow out its branches.

Deep Muscles.—These are the popliteus, crossing the bones close to the knee joint, the flexor longus digitorum on the tibial side, and on the fibular the flexor longus pollicis. The tibialis posticus is partially concealed by an aponeurosis which gives origin to the two flexors. It lies between the other two on the interosseous membrane. The three last-named muscles pass into the sole, and are there tendinous, as also are they beneath the malleolus.

The **Popliteus** is a triangular, flat, thin muscle, covered by a tendinous expansion from the semimembranosus. It *arises* within the capsule of the knee by a strong flat tendon an inch long from the anterior part of a deepish depression on the outer side of the external condyle, and outside the capsule some fleshy fibres arise from the posterior ligament of the knee. The tendon pierces the capsule and ends in the fleshy part of the muscle, which is *inserted* into the inner two-thirds of the triangular surface above the oblique line on the posterior aspect of the tibial shaft, and into the expansion covering the muscle.

Relations.—*Superficial* to it are the popliteal vessels and internal popliteal nerve, gastrocnemius, and plantaris. Its *deep surface* is in relation with the back of the upper part of the tibia and the superior tibio-fibular joint. Along its *upper border* are the internal inferior articular vessels and nerves, and its *lower border* is contiguous to the tibial and fibular origins of the soleus. In dissecting the knee its tendon of origin will be seen, and it will be noticed that it is in relation *externally* with the external lateral ligament and tendon of the biceps, and *internally* with the outer surface of the external semilunar cartilage, and is surrounded by the synovial membrane of the knee.

Action.—It assists in flexing the knee, and if the leg be flexed it can rotate the tibia inwards; the latter being fixed it will support and strengthen the knee on its outer side, and may slightly rotate the femur out. Theile thinks it retracts the external semilunar fibro-cartilage.

Nerve.—The internal popliteal nerve.

Varieties.—An accessory popliteus has, though very rarely, been observed.

The **Flexor Longus Digitorum**, or *perforans*, is on the tibial side of the leg, and *arises* by a pointed process from the posterior surface of the tibia just below the soleal attachments, immediately below the oblique

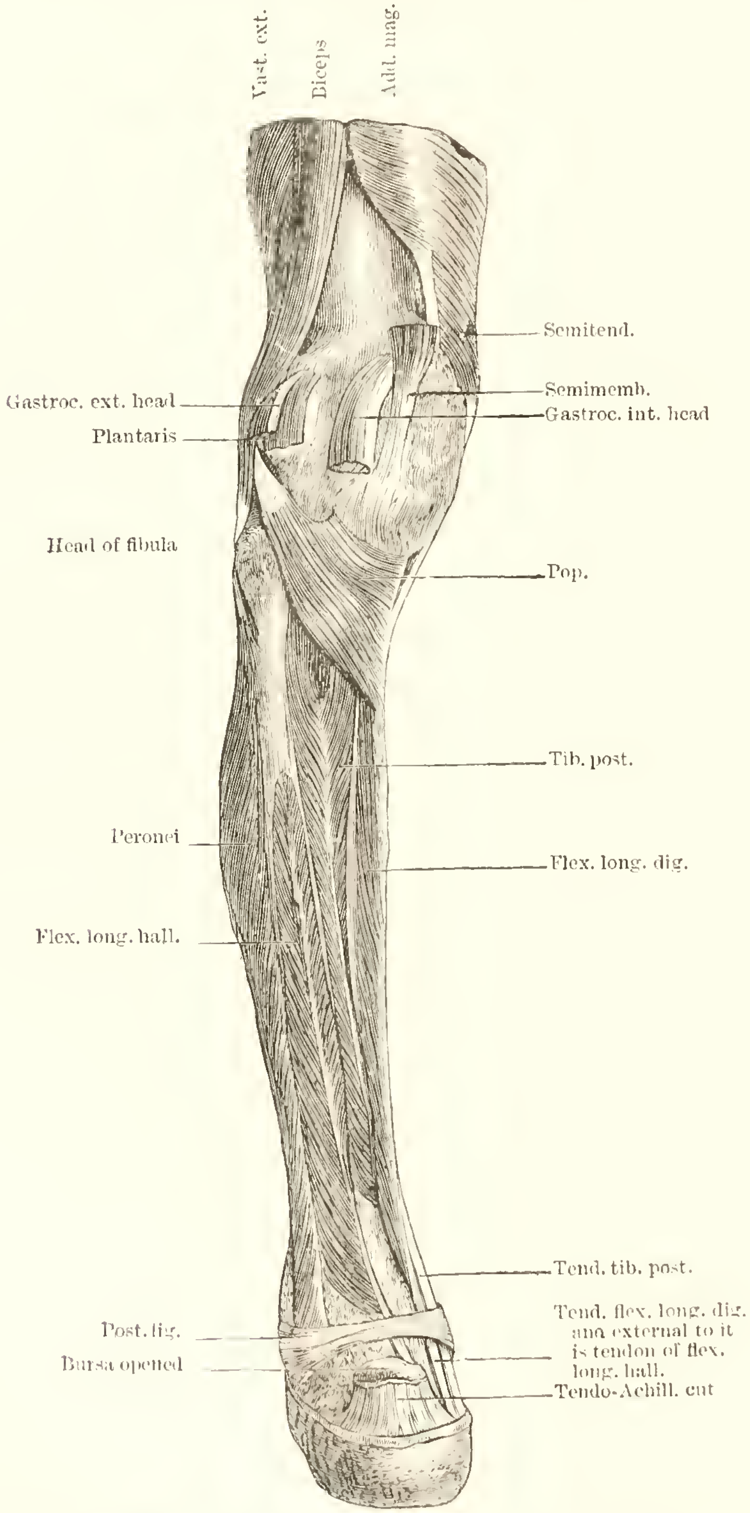


FIG. 350. DEEP LAYER OF MUSCLES AT BACK OF LEFT LEG.

line to within three inches of its lower end. The origin of this muscle from the tibia is internal to that of the tibialis posticus. Some fibres also

arise from the intermuscular septum, and from the aponeurosis over the tibialis posticus. The fleshy fibres end in a strong tendon which occupies nearly the whole length of the posterior aspect of the muscle. This tendon passes behind the internal malleolus in a groove on the posterior aspect of the tibia which is common to it and the tibialis posticus, but is separated from the latter muscle by a septum, the tendon of each being lodged in a special sheath and lined by a distinct synovial membrane. Beneath the internal annular ligament, and in the groove, its tendon is superficial to that of the tibialis, but in the lower fourth of the leg this muscle crosses in front of it. The tendon then passes forwards and outwards, beneath the os calcis into the sole, where it crosses beneath the tendon of the flexor longus pollicis, being connected to it by a strong tendinous slip. It then expands, and is joined on its outer side by the flexor accessorius about the middle of the sole. It finally divides into four tendons which are *inserted* into the bases of the last phalanges of the four outer or lesser toes on their plantar aspect. Each tendon passing through a slit in the corresponding tendon of the flexor brevis digitorum opposite the middle of the first phalanges. The lumbricales muscles arise from and are accessory to them in the sole. The insertion of this muscle cannot now be seen.

Relations.—Superficially with the soleus, the deep fascia, and the posterior tibial vessels and nerves. *Deeply* with the tibia and tibialis posticus. Its relations in the sole of the foot will be seen when that is dissected.

Actions.—It flexes the distal phalangeal joints of the four lesser toes, and then extends the foot, and assists the gastrocnemius and soleus in extending the foot in walking, or in standing on the toes. Were it not for the insertion of the flexor accessorius into the outer side of its tendon in the sole, it would in consequence of its oblique direction draw the toes inwards; but acting with the flexor accessorius, it draws the toes to the mid-line of the foot. Acting from below it steadies the tibia and fibula upon the ankle. It also helps to raise the heel in walking, and its tendon can, jointly with this and the other two muscles, strengthen the tarsal arch on its inner and under aspects.

Nerve.—The posterior tibial.

Varieties.—A second head of origin is not infrequent, and this may come from the outer tuberosity of the tibia, from the fibula, or from the deep fascia, and Otto has seen this extra piece joining and even replacing the flexor accessorius in the sole. A slip from the posterior aspect of the tibia (*flexor digiti secundi proprius*) may pass to the second toe, and there may be an additional slip from the tibialis anticus to join the flexor digitorum at the ankle. A small supernumerary muscle arising from the inferior part of the back of the tibia and running in the sheath of the long flexor of the toes to the posterior or inner ligament of the ankle (*tensor capsuli tibio-tarsalis*), may exist. (Gies, 'Archiv für Anatie.,' 1868).

The **Flexor Longus Hallucis, or Pollicis Pedis**, is placed on the fibular side of the leg, and is the largest, strongest, and most superficial of these muscles. It *arises* below the soleus from about the lower two-thirds of the posterior and internal surface of the shaft of the fibula to within an inch of its lower end, from the intermuscular septum between it and the peronei, from the fascia over the tibialis posticus, and from the lower part

of the interosseous membrane. Its fibres run obliquely down and back, and end around a tendon which occupies the lower half of the posterior surface of the muscle. The tendon passes through a separate groove on the posterior surface of the tibia, external to the tendons of the tibialis posticus and flexor longus digitorum, being near the tendo-Achillis. It then enters another groove on the posterior surface of the astragalus, and finally runs along a third groove beneath the lesser process of the os calcis, nearest its base, into the sole of the foot; it then passes between the two heads of

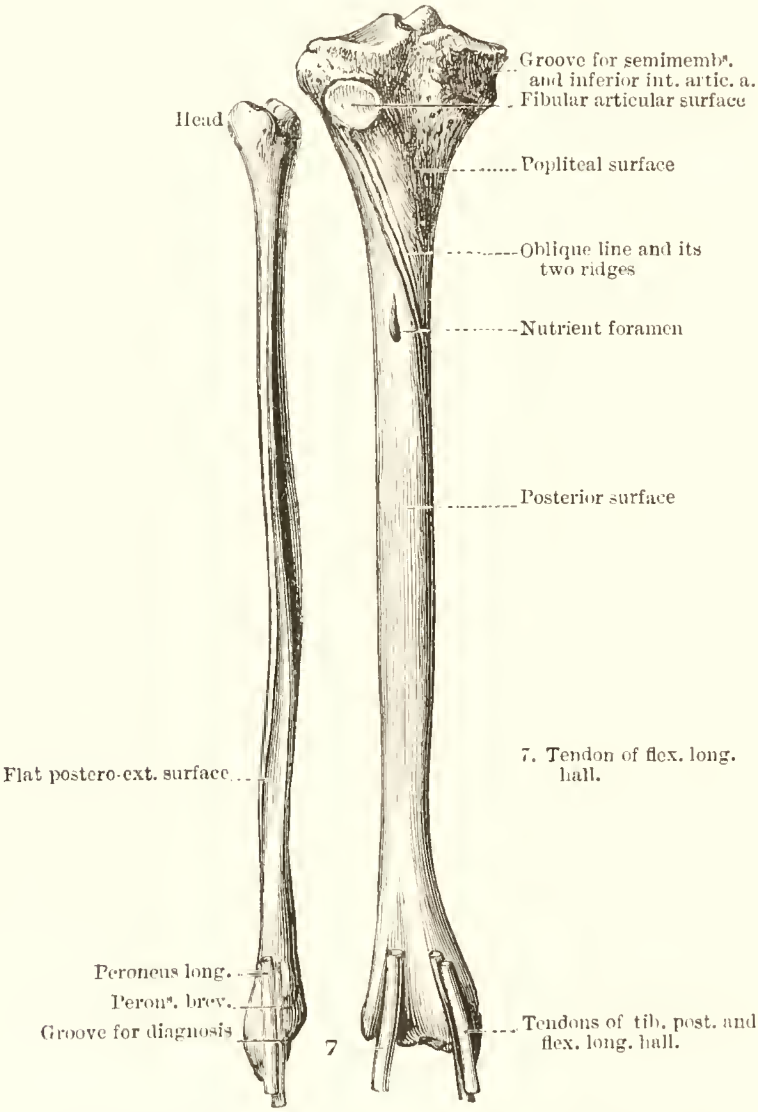


FIG. 351.—LEFT TIBIA AND FIBULA. POSTERIOR VIEW.

To show relations of tendons.

the flexor brevis pollicis, and is *inserted* into the base of the last phalanx of the great toe on its plantar aspect. In the sole it crosses *above* the tendon of the flexor longus digitorum, being connected to it by a strong tendinous slip. The astragaloid and calcanean grooves for this tendon are converted into distinct canals by tendinous fibres. These canals are lined by synovial membrane.

Relations.—Superficially it is separated from the soleus by the deep fascia, and from the tendo-Achillis by the deep fascia and some vascular

areolar tissue. Its *deep surface* is in relation to the peroneal vessels, the tibia, and fibula, the lower part of the interosseous membrane, and the back of the ankle joint. On its *inner side* are the posterior tibial vessels and nerve, the tibialis posticus, and flexor longus digitorum; and on its *outer side* are the peronei, separated by the intermuscular septum.

Actions.—It bends the distal phalanx of the great toe and then extends the ankle. It assists the flexor longus digitorum and gastrocnemius and soleus in extending the foot in walking or standing on the toes. If the foot be on the ground it will aid the flexor longus digitorum in raising the heel in walking, and will assist them mostly in moving back the bones of the leg when rising from a stooping posture; it also helps to steady the tibia and fibula on the ankle joint.

Nerve.—The posterior tibial.

Varieties.—Its peculiarities are few, but the manner of its union with the tendon of the longus digitorum is very variable, so that Professor Turner thinks that no two subjects are alike in this respect. In nearly all cases the slip of junction comes from the flexor hallucis, but in one-sixth of the subjects the digitorum sends a slip to the pollicis. The slip from

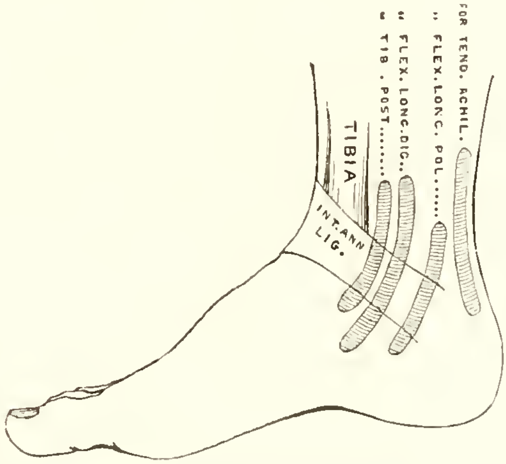


FIG. 352.—DIAGRAM OF THE SYNOVIAL SHEATHS OF THE TENDONS ON THE INNER SIDE OF RIGHT FOOT.

the hallucis generally is inserted into the second and third toes, but it may go to all four toes, or to the second only.

Macalister has described a small *peroneo-calcaneus internus* as being probably homotypical with the pronator quadratus. It arises behind the external malleolus from an oblique line on the back of the fibula, and passes over the sustentaculum tali in the same groove with the flexor hallucis, to be inserted into a tubercle of the os calcis (Macalister, 'Muscular Anomalies,' p. 125).

The **Tibialis Posticus** is the most deeply placed of these muscles, and lies between them. It *arises* by two pointed processes between which the anterior tibial artery passes to the front of the leg. Its origin differs from the other two muscles, as it arises from *both* bones. Its *tibial* origin is from the posterior surface of the shaft, external to the flexor digitorum, and between the upper part of the oblique line and the middle of the external border of the bone. Its *fibular* attachment is from the upper two-thirds of the inner surface of the shaft of the fibula. It also arises from nearly the whole of the posterior surface of interosseous membrane, except

about an inch below, from the aponeurosis which is superficial to it, and from the intermuscular septum. In the lower fourth of the leg it passes in *front* of the flexor digitorum and ends in the tendon which

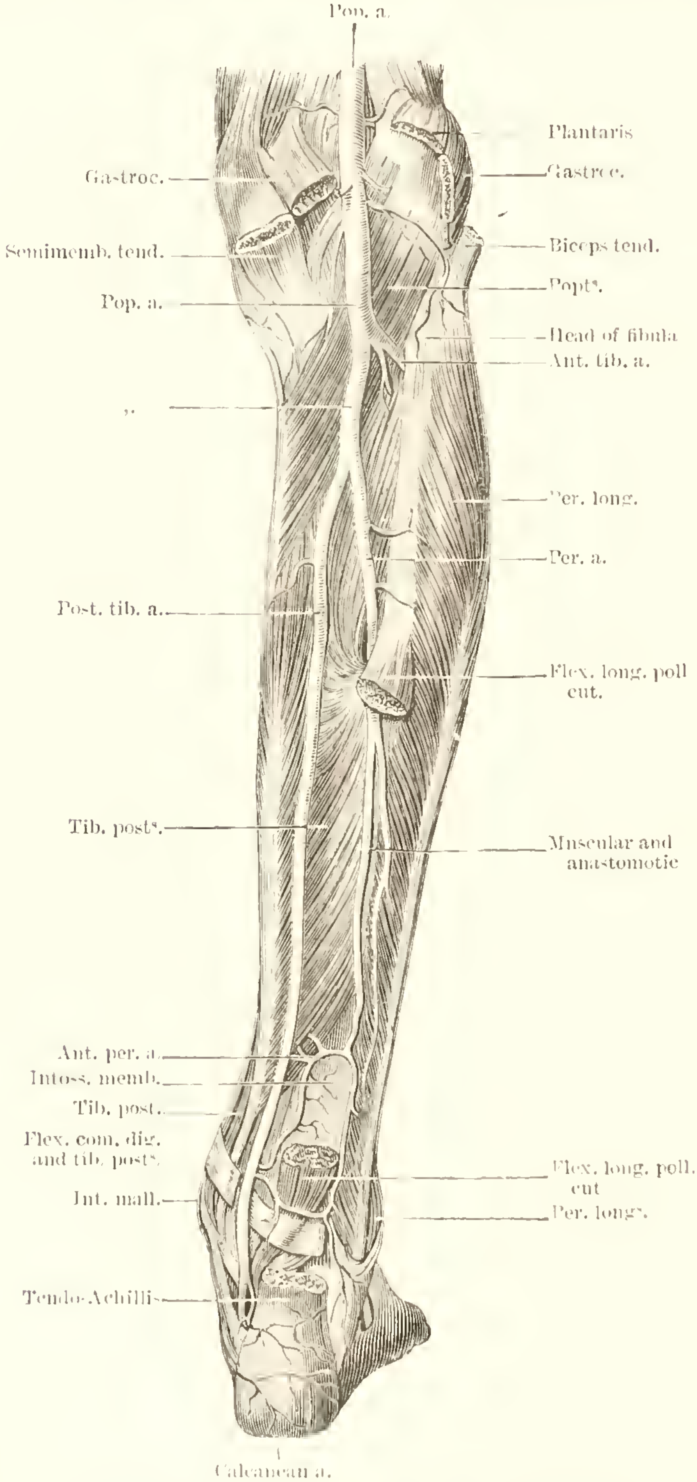


FIG. 353.—ARTERIES OF BACK OF RIGHT LEG.

The articular and sural are shown in the popliteal space.

enters the innermost groove behind the malleolus, being separated from the flexor digitorum by a septum. Its tendon then occupies another sheath *over* the internal lateral ligament and beneath the calcaneo-scaphoid

articulation, and expands to be *inserted* into the tuberosity of the scaphoid and internal cuneiform bones. A sesamoid bone is found near its insertion, and its tendon gives off expansions, the *posterior* of which is inserted into the sustentaculum tali of the os calcis, the *external* into the middle and external cuneiform bones and cuboid, and the *anterior* to the bases of the second, third, and fourth of the metatarsal bones; in fact, to all the tarsal bones except the astragalus and scaphoid.

Relations.—*Superficially*, the posterior tibial vessels and nerves, and the peroneal vessels, from which it is separated by the deep fascia; the soleus and flexor digitorum are also above it. *Deeply* it is in relation with the interosseous ligament, tibia, fibula, and ankle joint; and at the back of the malleolus it is between the tibia and the long flexor of the toes.

Actions.—It extends the ankle joint and acting with the anticus it turns the toes inwards, antagonising the peronei which turn it out. It shortens the inner border of the foot by drawing the scaphoid down and in, and assists the calf muscles in raising the heel in walking. In rising from stooping it assists the soleus in drawing back the bones of the leg. Its tibial origin is higher than the fibular.

Nerve.—The posterior tibial.

The *Aponeurosis* over the tibialis posticus has, inferiorly, a defined border, and is attached laterally to the leg bones. Its superficial surface gives origin to the flexors, and its deep surface to the tibialis posticus.

The **Posterior tibial artery** is large, and passes obliquely down from its origin from the popliteal, at the lower border of the popliteus muscle. It runs to the inner side of the leg, and passing in the mid-line between the heel and the inner malleolus, it divides beneath the origin of the abductor pollicis at the lower part of the internal annular ligament, into the *external* and *internal plantar* arteries. A line from the middle and lower part of the popliteal space to midway between the inner malleolus and the tuberosity of the os calcis will indicate its position.

Relations.—*Anterior* to it are the tibialis posticus, flexor digitorum, tibia, and the back part of the ankle. *Behind* it are the deep fasciæ, separating it from the gastrocnemius and soleus. In the lower third it is more superficial, and runs parallel with the inner edge of the tendo-Achillis, being covered only by the skin, superficial and deep fasciæ. Its venæ comites closely surround it, and the posterior tibial nerve is internal to it at its upper third, but at its lower two-thirds, it becomes external. Between the malleolus and the os calcis it has the following relations. On the inner side are the tendons of the tibialis posticus and flexor digitorum; on either side of it is a vein, the nerve being to its outer side, and half an inch nearer the heel is the tendon of the flexor longus pollicis.

RELATIONS OF THE POSTERIOR TIBIAL ARTERY.

In front are the tibialis posticus, flexor longus digitorum, tibia, and ankle joint.

Inside.—Post. tibial nerve at upper third. Vein.

Posterior Tibial

Outside.—Post. tibial nerve lower two-thirds, flexor long. hallucis at the ankle, and vein.

Behind are the intermuscular fascia, gastrocnemius, soleus, fasciæ, and skin.

Branches.—These are the peroneal, which is its largest branch, muscular, nutrient to the tibial, communicating, internal calcanean, articular, and cutaneous.

The *Muscular* branches supply the deep muscles and the soleus. An offset from the branch to the last-named muscle pierces its tibial attachment and supplies the knee.

The *Nutrient* artery to the tibia generally arises from the upper part of the posterior tibial; it gives a few muscular offsets and enters the nutrient canal on the posterior surface of the bone obliquely from above downwards. It is the largest nutrient artery of bone in the body, and ramifies in the interior of the tibia.

The *Communicating* artery to the peroneal passes transversely across the tibia about two inches from its lower end, and courses down and out beneath the flexor hallucis, to join a corresponding branch from the peroneal.

The *Calcanean* or *internal calcanean* are largish vessels which are given off from the posterior tibial just before it divides. They supply the

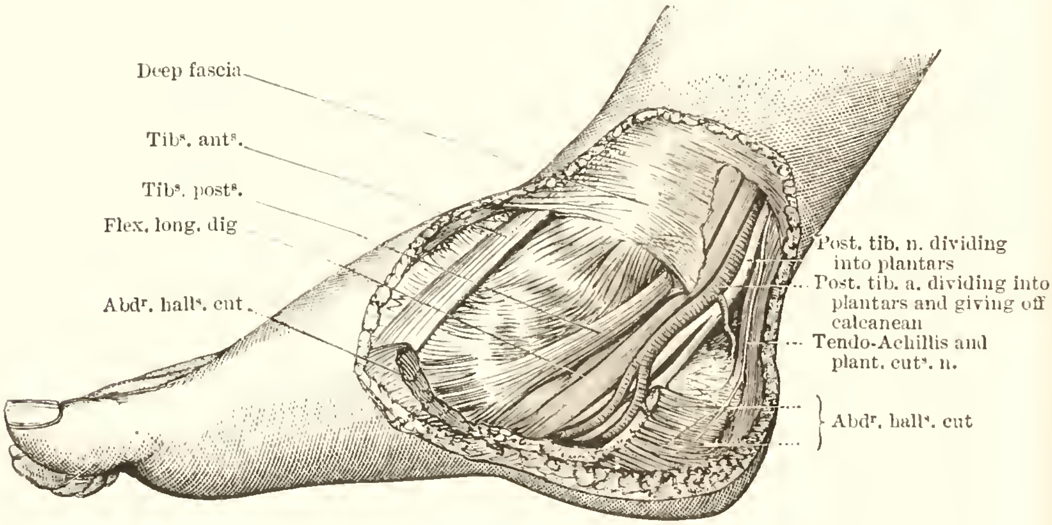


FIG. 354.—DISSECTION OF INNER SIDE OF RIGHT ANKLE.

skin and fat about the heel and under the tendo-Achillis. One large branch accompanies the plantar cutaneous nerve to the sole of the foot and pierces the internal annular ligament. They anastomose with the internal malleolar and peroneal arteries.

Cutaneous twigs pierce the fascia in the lower half of the leg, and articular branches enter the ankle joint on its inner and posterior side.

The **Peroneal Artery** is given off usually about an inch and a half below the lower border of the popliteus. It is often as large and sometimes larger than the posterior tibial itself, and passes obliquely outwards piercing the flexor longus pollicis, accompanied by the nerve of that muscle, and running close to the fibula along its inner border and in the substance of the muscle to the lower third of the leg, where it gives off the anterior peroneal. It then crosses the back of the inferior tibio-fibular articulations to the outer side of the heel, where it ends in branches which supply the skin, cellular tissue, and neighbouring muscles, and anastomoses

with the external malleolar, external plantar, tarsal and internal calcanean arteries. The nerve to the flexor longus pollicis is generally found on it, and its venæ comites surround it.

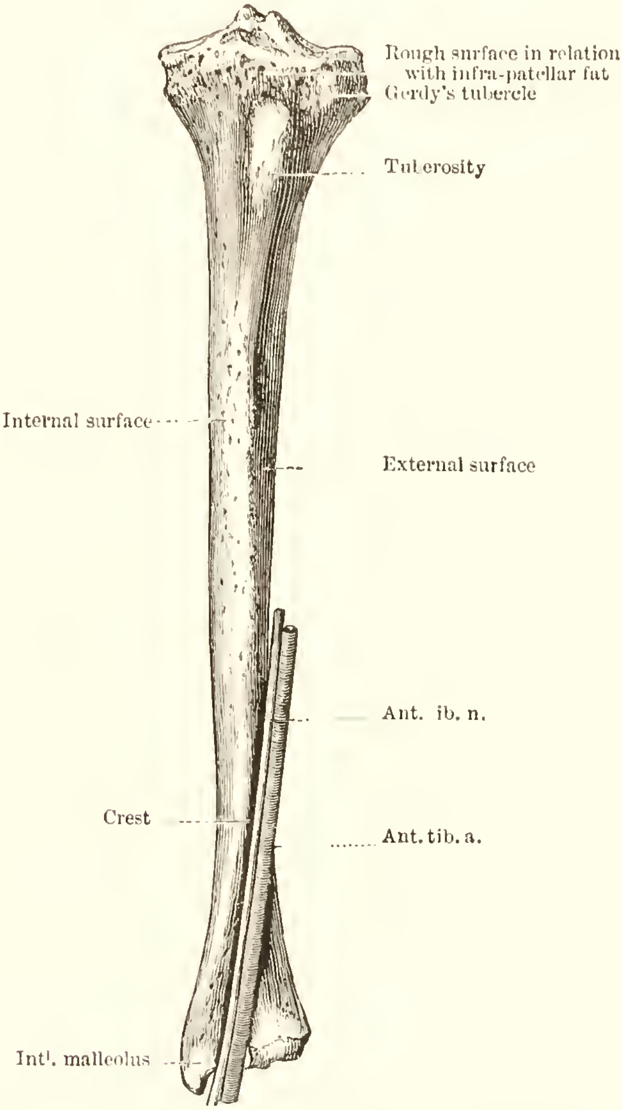
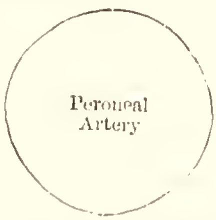


Fig. 355.—Left tibia, seen from the front, to show relation of artery and nerve to it.

Relations of the Peroneal Artery.

In front.—The tibialis posticus and flexor longus hallucis.

Outside.—The fibula.



Inside.—Tibialis posticus.

Behind.—Flex. long. hallucis, deep transverse fascia, and soleus.

Relations.—At first it lies on the tibialis posticus, but in the greater part of its course it is imbedded deeply in the flexor pollicis, in a groove between the fibula and the interosseous membrane. In the upper part of its course it is covered by the deep fascia and its companion nerve, and gastrocnemius; and below by the flexor longus pollicis. At its *outer* side is the fibula; on its *inner* side, at its upper part, the tibialis posticus.

Branches.—These are muscular, nutrient, anterior peroneal, and communicating.

The *Muscular* branches supply the soleus, tibialis posticus, flexor pollicis, and peronei.

The *Nutrient* pierces the tibialis posticus, and enters the foramen about the middle of the back of the fibula.

The **Anterior peroneal** pierces the interosseous membrane about two inches above the external malleolus beneath the lower and outer border of

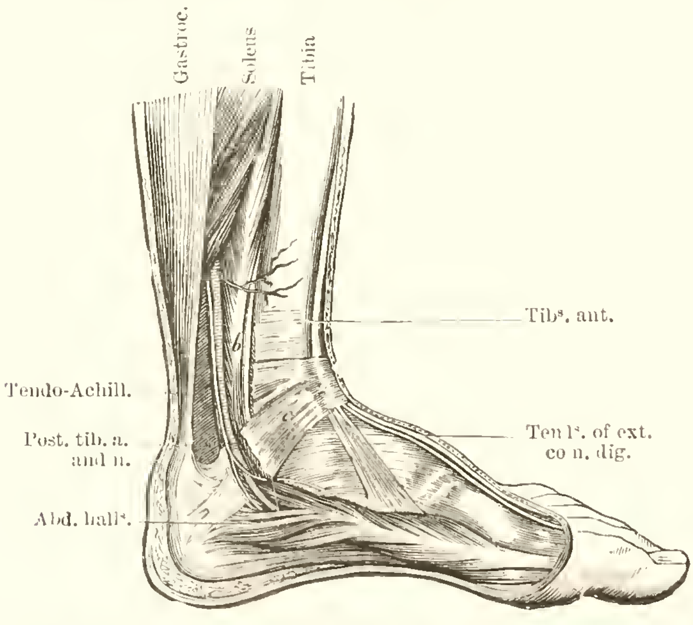


FIG. 356.—DISSECTION OF INNER SIDE OF LEFT FOOT.

b is on the flex. long. dig., and the tendon of tib. post. is between it and tibia. *c* is on lower piece of ant. ann. lig.

the tibialis posticus, or passes below that membrane to the front of the leg and passes beneath the peroneus tertius to the front and outer side of the tarsus, where it anastomoses with the external malleolar and tarsal arteries.

The *Communicating* branch is given off just above the ankle, and joins a similar branch from the posterior tibial. A second arch, a little lower down, sometimes exists between these vessels.

The *Posterior tibial veins* are formed on the inner and back part of the foot by the junction of the plantar. They accompany the artery and receive branches corresponding with those of the posterior tibial, and in their course receive the peroneal veins, being joined by the saphenous vein, and they finally unite with the anterior tibial at the lower edge of the popliteus muscle to form the popliteal vein. The valves in the deep veins of the leg are numerous.

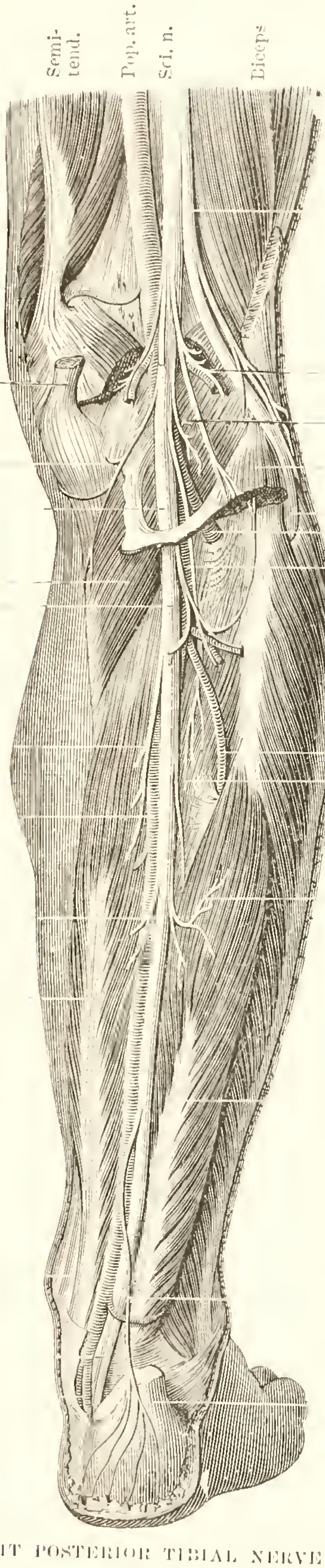


FIG. 357.—RIGHT POSTERIOR TIBIAL NERVE AND ARTERY.

The internal popliteal nerve is seen passing beneath the fibrous arch of the soleus.

The **Posterior Tibial Nerve** is a continuation of the internal popliteal, commencing at the lower border of the popliteus and passing down with the artery to the space between the internal malleolus and the heel. It divides beneath the internal annular ligament, or sometimes a little higher, into the internal and external plantar nerves. Its relations are the same as those of the artery, but at first for about a couple of inches it lies to the inner side of the vessel, and then crosses to its outer side as far as its division. It is parallel with the inner border of the tendo-Achillis in the lower third of the leg.

Its *branches* are muscular and plantar cutaneous.

The *muscular* branches either arise separately, or are given off by a common trunk from the upper part of the nerve. They supply the tibialis posticus (this is the largest branch), the flexor longus digitorum, and the flexor longus pollicis. The branch to this muscle usually lies on the peroneal artery.

The *Plantar Cutaneous* branches pierce the internal annular ligament in two or three offsets, and supply the skin of the inner and under parts of the heel and sole of the foot.

The *Internal Annular Ligament* is triangular, and extends from the inner malleolus to the inner margin of the os calcis. It converts the bony grooves into osseo-fibrous canals for the passage of the flexor muscles and vessels into the sole. Its upper border is continuous with the deep fascia of the leg, and its lower with the inner piece of the plantar fascia, and with the origin of the abductor pollicis. It is pierced by the plantar cutaneous nerve and some of the internal calcanean vessels. Beneath it the tendons of the three deep muscles pass into the foot, each being covered by a separate synovial membrane. The innermost sheath contains the tibialis posticus, immediately behind it is the flexor longus digitorum, and about three-quarters of an inch nearer the heel is the tendon of the flexor longus hallucis. The posterior tibial vessels and nerve run through a broad space beneath the ligament, being placed between the tendons of the flexors digitorum and hallucis, the nerve being to the outer side.

SOLE OF THE FOOT.

Directions.—The foot is to be placed with the sole towards the dissector. The toes should be separated and fixed to the table or block, near their extremities, by small nails, and the skin made tight by passing hooks through it over the heel prominence. An incision from the centre and back of the heel to the end of the middle toe; and another across the roots of the toes must be made. On reflecting the skin the following cutaneous vessels and nerves will be seen in the subcutaneous fat. Near the heel, on its inner side, the plantar cutaneous branch of the posterior tibial nerve will be seen. On the inner and outer sides will be noticed branches of the external and internal plantar nerves and vessels. The digital vessels and nerves on the sides of the toes will also come into view.

The subcutaneous fat of the sole is plentiful, and forms a thick layer over the os calcis and the metatarso-phalangeal articulations, the parts that are most exposed to pressure. Fibrous or fibro-muscular processes

pass from the plantar fascia to the deep surface of the skin, and these serve to keep the skin in place during the movements of progression. Remove this fat until the glistening plantar fascia becomes visible. The processes of this fascia must be traced towards the toes, and in the

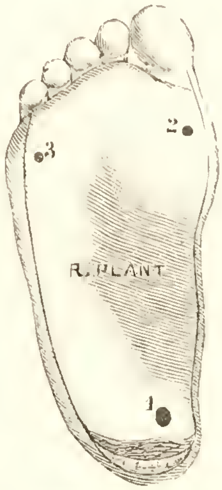


FIG. 358.—DIAGRAM OF INCISIONS AND OF THE THREE CHIEF POINTS OF PRESSURE IN THE SOLE. RIGHT FOOT.

intervals between them, concealed in fatty and fibrous tissue, will be found the deeper parts of the digital arteries and nerves. The nerves and vessels to the outer side of the little toe, and inner side of the great

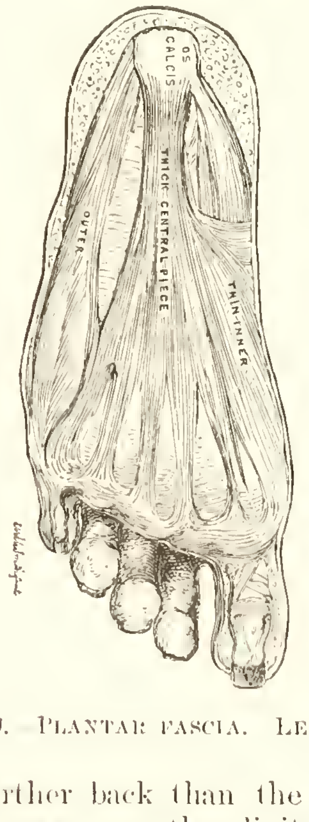


FIG. 359. PLANTAR FASCIA. LEFT FOOT.

toe, perforate the fascia further back than the others. An interdigital transverse fibrous band passes over the digital vessels and nerves, and after making this out the student should clean the superficial fascia from

one or two toes and expose the tendinous sheaths. The scalpel should follow the course of the plantar fascia, which is from before backwards.

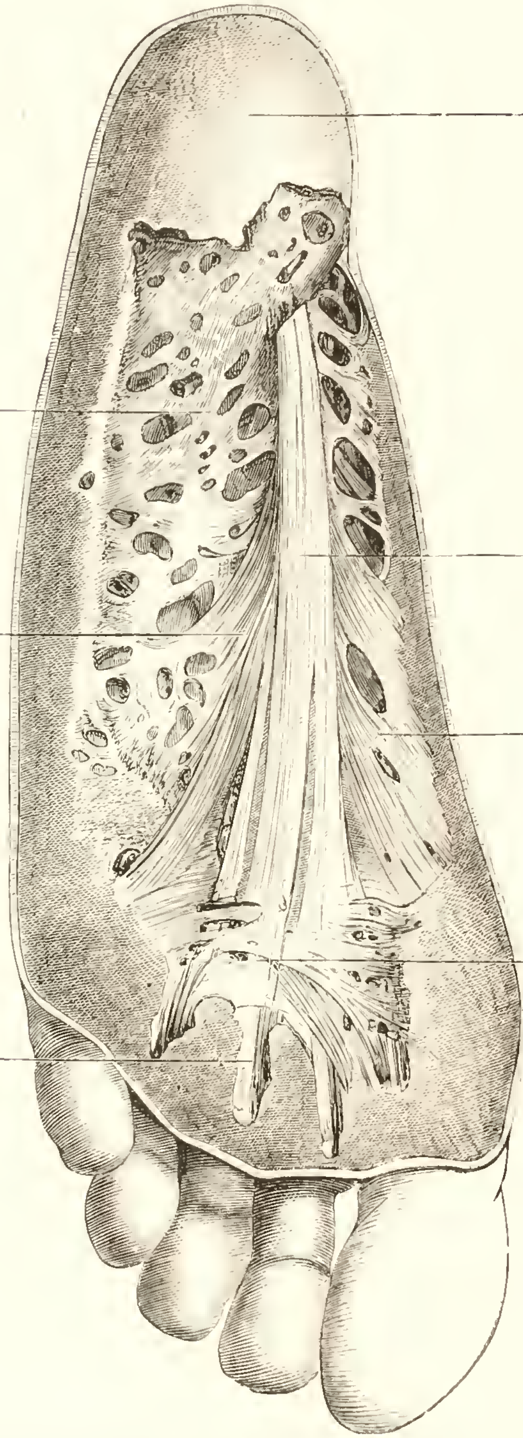


FIG. 360.– PLANTAR FASCIA OF LEFT FOOT.

The fenestrated pieces on inner and outer side of the central piece are attached to the deep layer of the skin.

The subcutaneous fat must be carefully removed from the inner side of the foot or the internal part of the plantar fascia will be destroyed.

The *Plantar fascia* is the strongest of all the fibrous membranes, and

is of a dense pearly white colour. Its fibres run for the most part longitudinally, and its thickness varies in different parts of the foot. There are two main intermuscular septa which divide it into a central and two lateral parts.

The *Central Portion* is much the thickest, being narrow behind where it is attached to the *inner* tubercle of the os calcis, behind the origin of the flexor brevis digitorum. It becomes thinner and wider in front, and opposite the heads of the metatarsal bones it divides into five processes for each of the toes, after having given off bands to the interdigital webs. Opposite the metatarso-phalangeal articulation each of these processes divides into two slips which cover the joints of the flexor tendons of the toes and are attached to the sides of the metatarsal bones, and into the transverse metatarsal ligament. A series of arches is thus formed

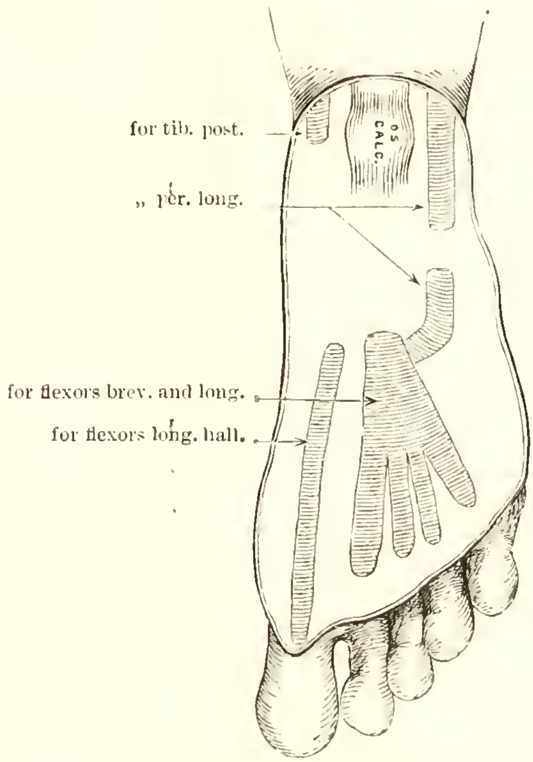


FIG. 361.—DIAGRAM OF SYNOVIAL SHEATHS OF RIGHT SOLE

through which the short and long flexor tendons pass to the toes. In the spaces between the five processes, the digital vessels and nerves and the tendons of the lumbricales become superficial. At the spot where the processes and slips are given off, will be found numerous transverse fibres binding them together, increasing their strength and connecting them with the skin. The central portion of the fascia is continuous with the lateral pieces, and at their point of junction sends upwards two vertical strong intermuscular septa which are broader in front, and which separate the middle plantar muscles from the external and internal groups. These vertical septa give off thin transverse intermuscular septa which separate the various layers of plantar muscles.

The *lateral pieces* of the plantar fascia cover the sides of the foot, and

are thinner than the central portion. These pieces cover the abductor pollicis and minimi digiti. The *outer* portion is thicker than the inner, and thicker behind than in front, extending from the os calcis to the outer side of the base of the fifth metatarsal (*calcaneo-metatarsal ligament*). It is continuous with the middle portion of the plantar fascia, and externally with the fascia of the dorsum of the foot. The *inner* portion is very thin over the abductor pollicis, is fixed behind to the

FIG. 362.—SUPERFICIAL DISSECTION OF RIGHT FOOT.

66. Collateral digital arteries. The transverse processes joining the five divisions of the plantar fascia, and fixing down the tendons, are shown; also the digital sheaths of the tendons with their oblique and transverse processes.

internal annular ligament, and is continuous with the middle portion of the plantar fascia, and internally with the dorsal fascia.

Dissection.—Before removing the plantar fascia to expose the first layer of muscles, the student should examine the intermuscular septa. To do this, a longitudinal incision through the middle central piece should be made, and a transverse one near the heel. It must then be reflected from the subjacent flexor brevis digitorum until the septa on either side are reached. It will now be seen that the flexor brevis digitorum is en-

closed between these lateral septa and the central piece of the plantar fascia. The *outer* septum passes up between the flexor brevis digitorum and abductor minimi digiti, and the digital vessels and nerves for the outer side of the little toe pierce it; the *inner* septum passes between the flexor brevis and the abductor pollicis; the flexor longus pollicis and the internal plantar nerve and vessels perforate it.

Between the layers of skin forming the interdigital webs the student must seek the superficial transverse ligament. This consists of transverse fibres, and is connected with the sheaths of the flexor tendons over which it passes, forming a series of arches. It is attached on the outer and inner sides to the sheaths of the tendons of the four lesser toes. Beneath it are the digital vessels and nerves.

The *sheaths of the flexor tendons* resemble those of the hand, but are less distinct. They are weaker opposite the interphalangeal articulations, but strong opposite the middle of the proximal and middle phalanges.

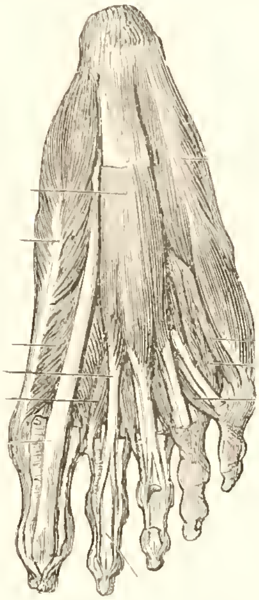


FIG. 363.—SUPERFICIAL MUSCLES OF THE RIGHT SOLE.

Each contains a tendon of the long and short flexor covered by a synovial membrane which forms synovial sheaths for them.

Dissection.—Remove the plantar fascia, being careful of the digital vessels and nerves which are superficial to the flexor brevis digitorum near the toes. Lay open the sheaths along one or two of the toes, so that the arrangement of the short and long flexor tendons may be studied. There are four layers of muscles in the foot which will be exposed in the various stages of the dissection.

First Layer.—All the pieces of the plantar fascia having been reflected, this layer will be exposed. There are three muscles forming it, viz. the flexor brevis digitorum or perforatus in the middle, the abductor pollicis on the *inner* side, and the abductor minimi digiti on the *outer*. The muscles of the foot may, like those of the hand, be divided into three groups, viz. those of the internal plantar regions connected with the great toe, corresponding with those of the thumb; those of the

middle plantar region; and those of the external plantar region, which are connected with the little toe, and correspond to those of the little finger.

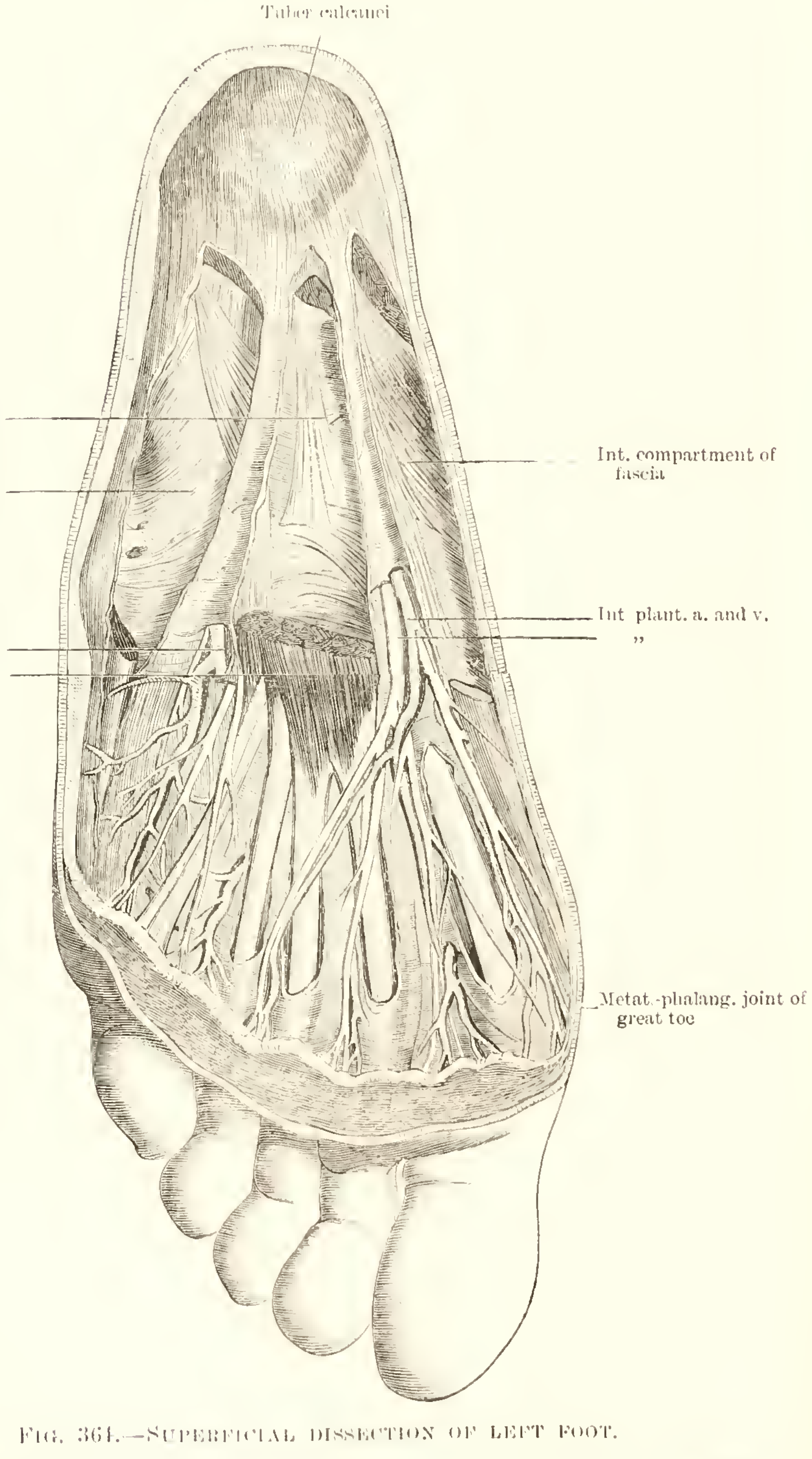


FIG. 364.—SUPERFICIAL DISSECTION OF LEFT FOOT.

The tendons of flex. brev. dig. and branches of internal and external plantar arteries and nerves are shown.

The **Abductor Pollicis,** or **Hallucis,** runs along the inner border of the foot, and *arises* from the inner part of the larger inner tubercle on the under

surface of the os calcis, from the lower border of the internal annular ligament, from the upper surface of the inner portion of plantar fascia, and from the intermuscular septum between it and the flexor brevis digi-

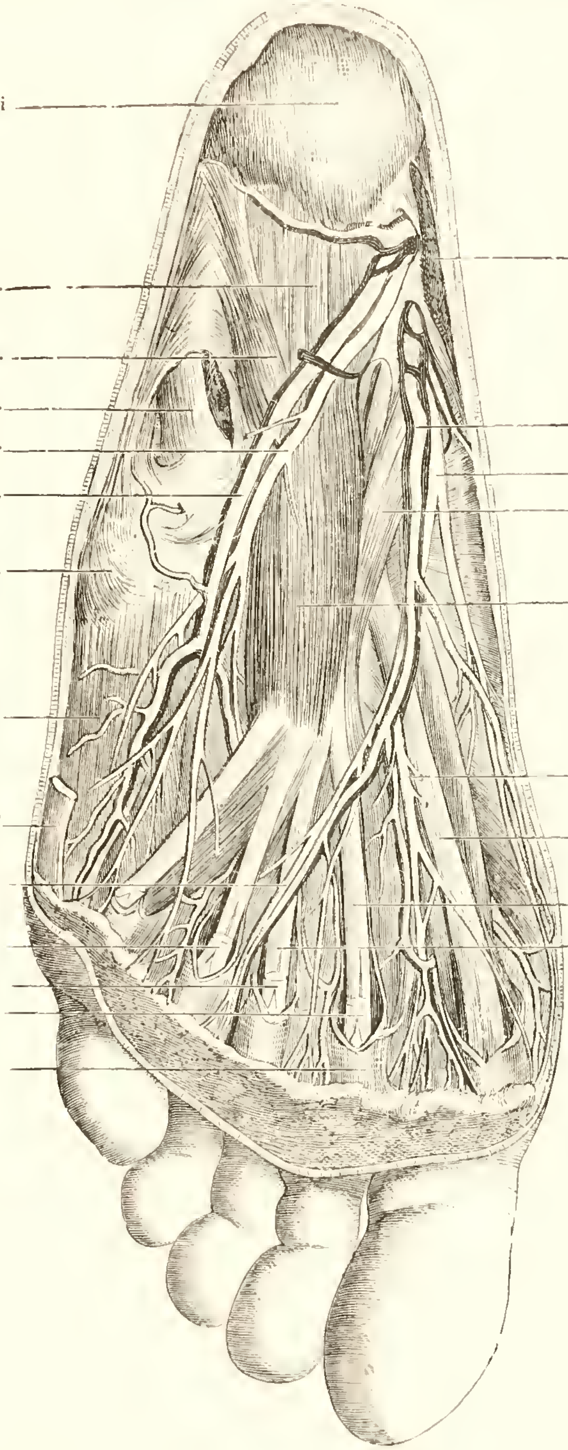


FIG. 365.—DEEPER DISSECTION OF LEFT FOOT, THE PLANTAR FASCIA REMOVED.

torum. It ends in a tendon which with the innermost tendon of the flexor brevis pollicis is *inserted* into the *inner* side of the base of the proximal phalanx of the great toe.

Relations.—By its *deep surface* with the flexor brevis pollicis, flexor accessorius, the tendon of the flexor longus pollicis, the innermost tendon of flexor longus digitorum, the tendons of the tibialis anticus and posticus, and the plantar vessels and nerves. It is in relation by its *superficial surface* with the plantar fascia.

Actions.—It is chiefly a flexor of the metatarso-phalangeal joint of the great toe, and a slight abductor.

Nerve.—The internal plantar.

Varieties.—It sometimes sends a slip to the base of the first phalanx of the second toe, and occasionally another to the skin of the ball of the great toe.

The **Flexor Brevis Digitorum, or flexor perforatus,** lies beneath (in the erect position, the muscle would of course be above the fascia) the middle piece of the plantar fascia, with which it is firmly united. It *arises* by a narrow tendon from the inner part of the inner tubercle of the os calcis, from the centre piece of the plantar fascia, and from the lateral intermuscular septa. Near the centre of the foot it divides into four small tendons which pass over (in this position of the foot) the tendons of the long flexor, and opposite the middle of the first phalanges of the four outer or lesser toes, each tendon has a longitudinal slit for the passage of the corresponding tendon of the flexor longus digitorum. The two pieces into which each tendon splits form a groove for the tendons of the long flexor; it then reunites and again divides into two processes which are *inserted* into the sides of the second phalanges. The student, if he have dissected the hand, will note the resemblance between these tendons and the flexor tendons of the hand.

Relations.—*Superficially*, with the plantar fascia; *deeply*, with the tendons of the flexor longus digitorum, the flexor accessorius and lumbricales, and the external plantar vessels and nerves, from which it is separated by a thin transverse layer of fascia.

Actions.—It flexes the first interphalangeal joint of the four smaller toes, and at the same time brings the toes together. The short and long flexors having bent the interphalangeal joints, will then flex the metatarso-phalangeal articulations.

Nerve.—The internal plantar.

Varieties.—It may have only three tendons, that for the little toe being absent; or it may have five, two going to the second toe. There may be a supernumerary fasciculus arising from the tendon of the long flexor and going to the tendons of the fourth and fifth toes. Frequently the tendon for the little toe comes from a small spindle-shaped belly, which arises from the side of the long flexor tendon or from the flexor accessorius; or it may arise by two heads, one from the long flexor, and another from the inner tubercle of the os calcis.

The **Abductor minimi digiti** *arises* by a broad piece from the outer tubercle to the os calcis, and from the anterior part of the inner tubercle, and slightly from the under surface of the calcaneum in front of the tubercles, also from the upper surface of the inner piece of the plantar fascia, and from the intermuscular septum. Its tendon glides over a smooth facet on the under surface of the base of the fifth metatarsal bone to which it is sometimes attached, and is *inserted* with the flexor

brevis minimi digiti into the *outer* side of the base of the first phalanx of the little toe.

Relations.—Superficially, with the plantar fascia; *deeply*, are the flexor accessorius, flexor brevis minimi digiti, the tendon of the peroneum longus, and the long plantar ligament. *Internal* to it, are the external plantar vessels and nerves, and the flexor brevis digitorum.

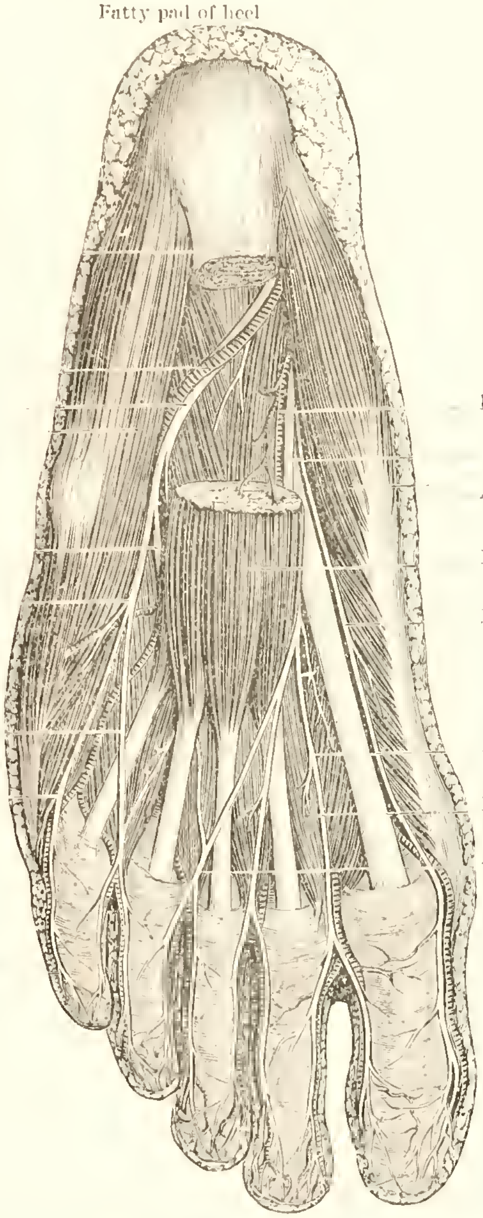


FIG. 366.—SUPERFICIAL DISSECTION OF LEFT FOOT.

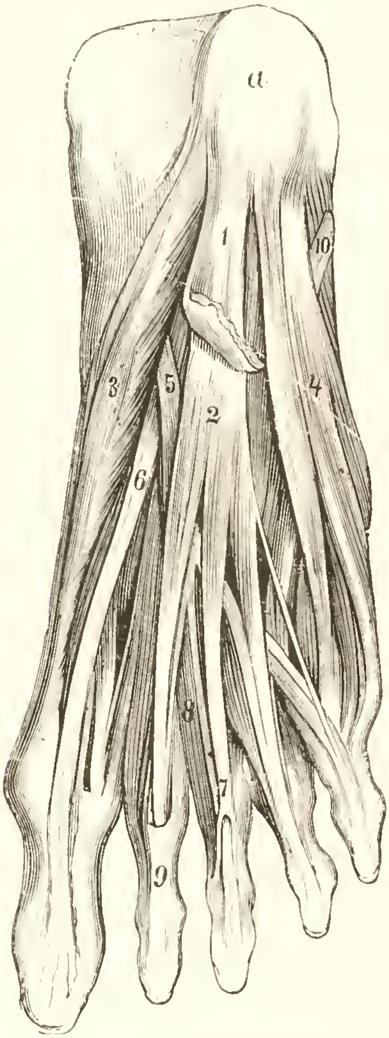
Action.—It abducts the little toe, but it is mainly a flexor of the metatarso-phalangeal joint of the little toe.

Nerve.—The external plantar.

Varieties.—Occurring about once in two subjects is an occasional muscle called the *abductor ossis metatarsi minimi digiti*, which may be adherent to the abductor minimi digiti and be inserted into the middle or anterior part of the metatarsal bone. It may arise from the external

tubercle of the os calcis and be inserted into the process of the base of the fifth metatarsal bone beneath the outer margin of the plantar fascia.

Dissection.—The second layer of muscles and plantar vessels and nerves may be exposed by two methods, viz. either by dividing the superficial muscles close to their origins and reflecting them, noticing a branch of nerve and artery to them; or by passing a small thin saw carefully underneath their origins, and sawing off a thin piece of the os calcis. This second method has the advantage of preserving the attachment of the superficial muscles which can be replaced afterwards if necessary.



a. Calcanean tubercle.
1. Plantar fascia reflected.
2. Flex. com. dig.
3. Abd. hall.
4. Abd. min. dig.
5. Tend. flex. long. dig.
6. Tend. flex. long. hall.
7. Tendons of flexors.
8. Lumbricales.
9. Sheath of tendons.
10. Tend. peron. long. part of flex access. between 2 and 4.

FIG. 367.—SUPERFICIAL PLANTAR MUSCLES OF RIGHT FOOT.

The internal plantar vessels and nerve must be cleaned from their origin to their termination, and the external plantar vessels and nerve, the tendons of the flexor longus digitorum with the flexor accessorius on its outer side, the lumbricales between its tendons, and the tendon of the flexor longus pollicis on its inner side and beneath it (in this position), must be cleaned.

The **Plantar Vessels** are the terminal branches of the posterior tibial artery, and in this part of the dissection will be found superficial to the tendons lying between the first and second muscular layers. They are

the external and internal plantar arteries of which the external is the larger and forms the plantar arch.

The **Internal Plantar Artery** is small, and runs along the inner border of the foot with the internal plantar nerve. It passes from above the abductor pollicis to between it and the flexor brevis digitorum, supplying both, to the third interosseous space. At the base of the first metatarsal bone it is very small and passes along the inner side of the great toe, anastomosing with its digital branch, and also with the third digital artery from the external plantar.

Branches.—It gives *muscular* offsets to the two muscles just mentioned, and also to the two inner lumbricales. Offsets pass to the

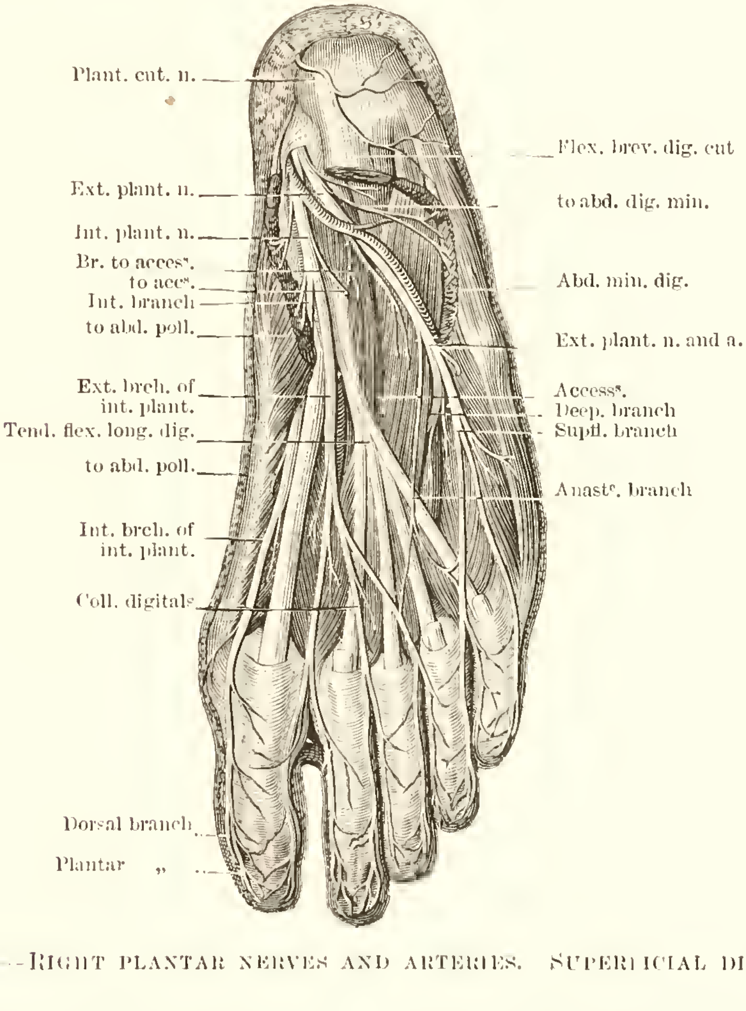


FIG. 368.—RIGHT PLANTAR NERVES AND ARTERIES. SUPERFICIAL DISSECTION.

inner border of the foot and join the dorsal arteries and *cutaneous* twigs which appear between the middle and inner pieces of the plantar fascia. It also furnishes *four digital branches* accompanying those of the internal plantar nerve. The *first digital* passes to the inner side of the foot and great toe. The *second* to the first interosseous space, the *third* to the second space, and the *fourth*, which is the termination of the artery, to the third space. At the roots of the toes the *three outer* ones join the deeper digital arteries from the external plantar.

The **External Plantar Artery**, the larger, passes obliquely forwards and outwards to the base of the fifth metatarsal bone, and then turns obliquely

inwards to the space between the bases of the first and second metatarsal bones, where it joins the communicating branch from the dorsalis pedis artery, completing the *plantar arch*. The concavity of this arch is turned inwards. It will be seen that this artery crosses the foot twice, first from within outwards and then in the opposite direction.

Relations.—In the first half of its course, viz. from the inner side of the os calcis to the base of the fifth metatarsal bone, it is comparatively superficial, being placed at first between the calcaneum and the abductor pollicis, and then between the flexor brevis digitorum and flexor acces-

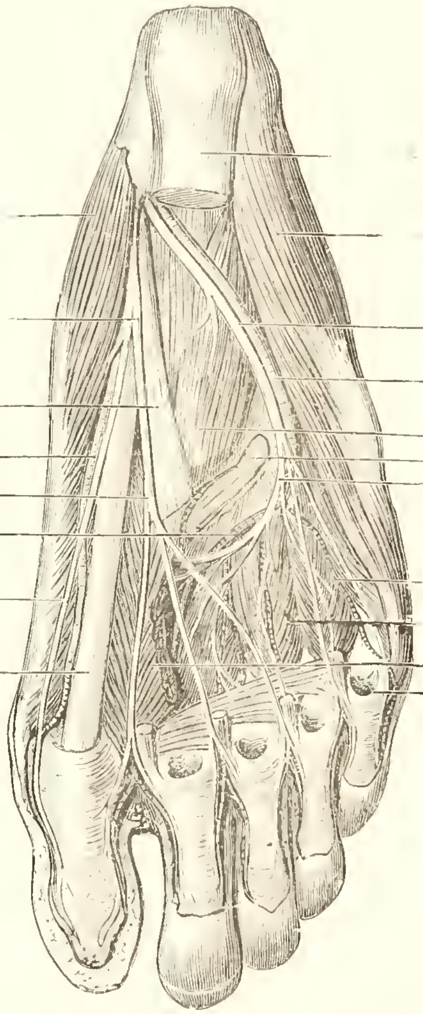


FIG. 369.—SECOND LAYER OF MUSCLES, AND ARTERIES AND NERVES OF THE RIGHT SOLE.

sorius, and near the little toe between the flexor brevis digitorum and abductor minimi digiti, covered by the outer piece of the plantar fascia and skin. In the rest of its extent it is deeply placed, lying upon the interosseous muscles opposite the bases of the metatarsal bones, covered by the adductor pollicis, the flexor tendons of the toes, and the lumbricales. In this part the arch is convex forwards. Only the *superficial* part of the artery is now seen. It is accompanied by venæ comites and the external plantar nerve, which is first on its outer side and crosses *above* it to reach

its inner side. The *deep part* will be dissected with the third layer of muscles. The superficial part gives numerous branches to the muscles between which it lies, and to the skin and fasciæ of the sole; and on the outer side of the foot anastomoses with the dorsal and peroneal artery.

RELATIONS OF EXTERNAL PLANTAR ARTERY.

Superficially.—Skin and fasciæ, abductor hallucis, flexor brevis digitorum, adductor hallucis, flexor tendons of toes and lumbricales.

Inside.—Ext. plantar nerve and tendons of flexor longus digitorum.

External Plantar Artery

Outside.—Abductor minimi digiti and tendon of peroneus longus.

Deeply.—Os calcis, flexor accessorius, base of fifth metatarsal, and interossei.

The **Plantar Nerves** are the terminal branches of the posterior tibial nerve, which divides between the internal malleolus and the os calcis.

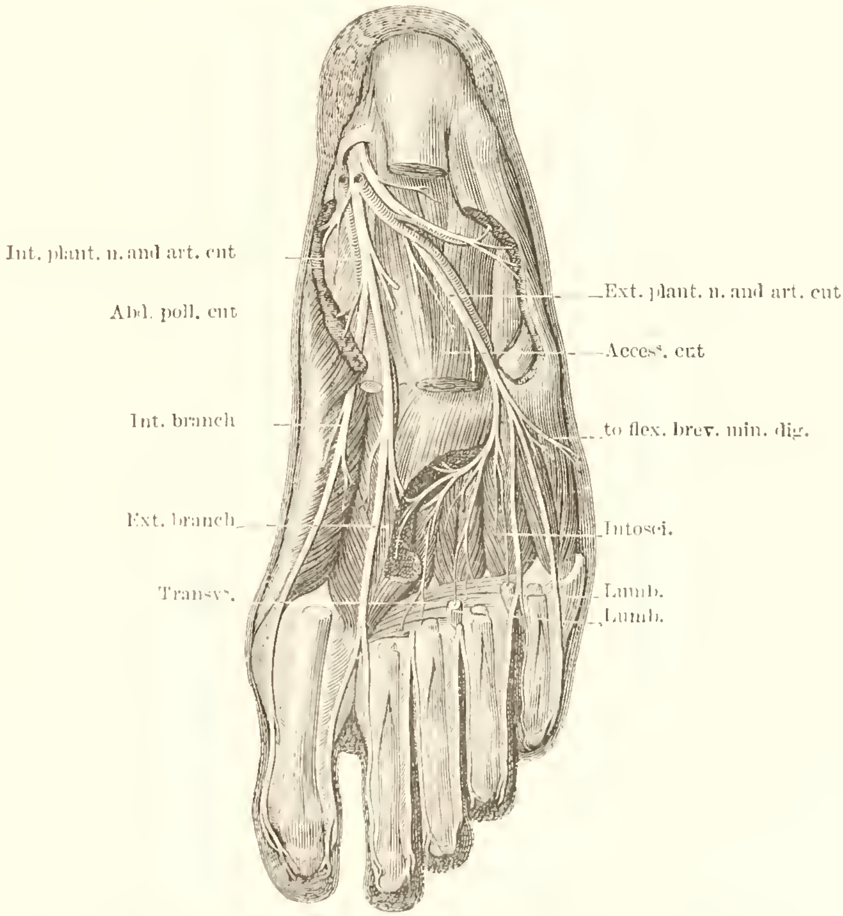


FIG. 370.—RIGHT PLANTAR NERVES AND ARTERIES. DEEP VIEW.

They accompany the plantar arteries, the larger nerve going with the smaller vessel. The external plantar nerve passes from the outer to the

inner side of its corresponding artery and crosses *above* it. The inner nerve crosses from the outer to the inner side of its corresponding artery *beneath* it (in the erect position).

The **Internal Plantar Nerve**, the larger, passes forwards between the abductor pollicis and flexor digitorum to the bases of the inner metatarsal bones, where it divides into four digital branches. It gives *muscular* twigs to the abductor pollicis and flexor brevis digitorum, and some *cutaneous* ones which pierce the plantar fascia and supply the skin of the inner side of the sole, also *articular* filaments to the inner tarsal and metatarsal joints, and ends in *four digital* branches, which pierce the plantar fascia in the clefts between the toes, passing with the digital arteries under the superficial transverse ligament to be distributed thus: the *first* is near the inner border of the great toe, and is undivided; before it reaches the toe it supplies the flexor brevis pollicis. The *outer three* nerves are bifur-

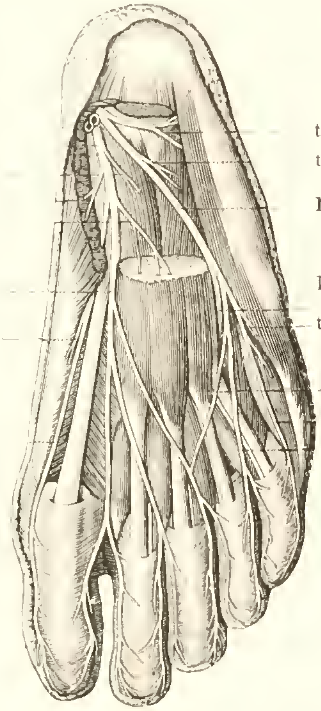


FIG. 371.—RIGHT PLANTAR NERVES. SUPERFICIAL DISSECTION.

cated at the interdigital clefts. The *second* digital supplies the contiguous sides of the great and second toes, giving a branch to the first lumbricalis. The *third* digital supplies the adjacent sides of the second and third toes, and the second lumbricalis. The *fourth* digital supplies the contiguous sides of the third and fourth toes, and communicates with the external plantar nerve. On the toes these nerves run with their corresponding digital arteries, and supply the interphalangeal joints, the skin, and the cutis beneath the nail.

The **External Plantar Nerve**, the smaller, is destined mainly for the deep muscles of the sole. It resembles the ulnar in the hand, the internal plantar resembling the median. It gives *digital branches* to both sides of the little toe and the outer side of the fourth toe. It accompanies the external plantar artery, lying between the flexor accessorius and flexor

brevis digitorum, and at the outer border of the latter, between it and the abductor minimi digiti, it divides into a *superficial and a deep branch*. Before division it supplies the abductor minimi digiti and flexor accessorius.

The *Superficial branch* separates into two digital nerves, the *smaller* of which supplies the outer side of the little toe and the flexor brevis minimi digiti and the two interossei muscles of the fourth metatarsal space. The *larger* digital branches supply the adjacent sides of the fourth and fifth toes, and join the last digital branch of the internal plantar nerve.

The *deep or muscular branch* of this nerve will be presently dissected.

Directions.—Cut the internal plantar artery and nerve near the heel,

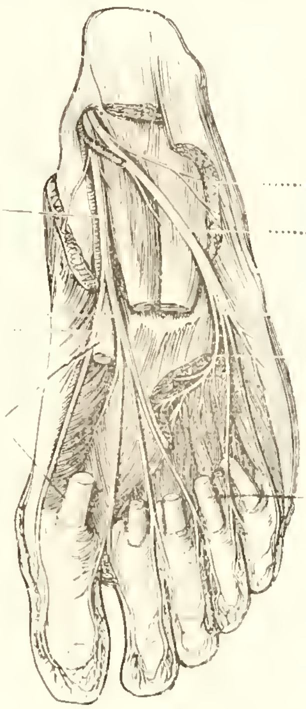


FIG. 372.—NERVES OF THE RIGHT SOLE.

and throw them forwards. Clean the external plantar artery and nerve, and remove any connective tissue and fat from the toes.

Second Muscular Layer.—The tendons of the long flexors of the toes, that of the flexor longus pollicis, the flexor accessorius, and the lumbricales will now be exposed.

The **tendon of the flexor longus digitorum** enters the sole of the foot beneath the internal annular ligament, and passes obliquely out towards its centre, where it is joined on its *outer* side by the flexor accessorius. It is also connected here with the tendon of the flexor longus pollicis, *over* which (in this position) it passes to the centre of the foot; it expands, and after being joined by the accessorius divides into four tendons which enter the flexor sheaths *with* and *beneath* the corresponding tendon from the flexor brevis, which it perforates about the middle of the first phalanges. It is finally *inserted* into the bases of the distal phalanges of the four *outer* toes. Between these tendons are the lumbricales muscles and the *vin-*

cula accessoria tendinum; the *ligamenta brevia* and the *vincula vasculosa* will be found in connection with them as in the hand. Their synovial membranes are inside the sheaths; and the *ligamenta vaginalia* of

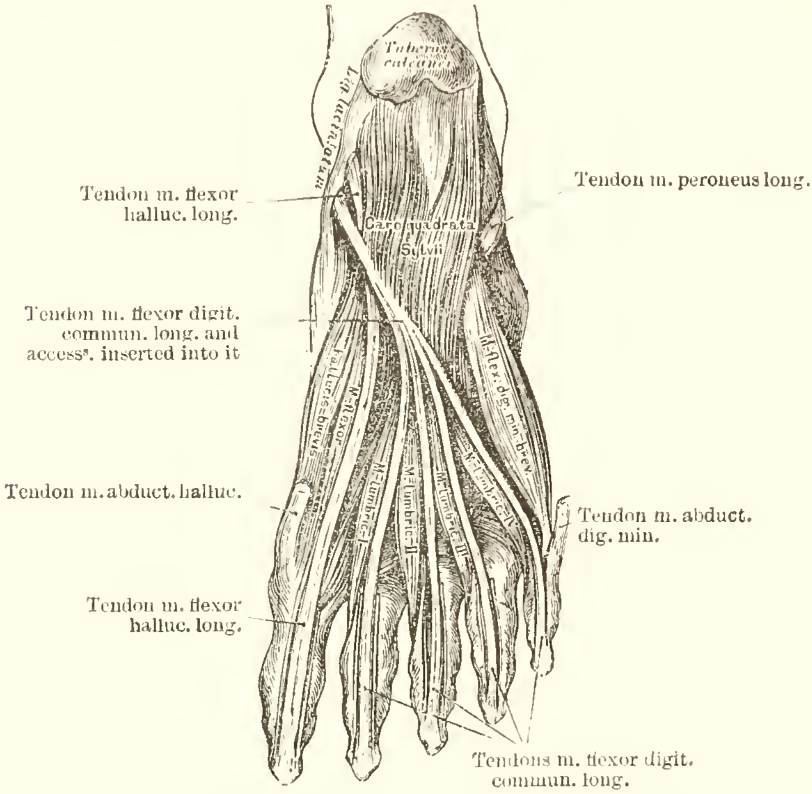


FIG. 373.—THE SECOND MUSCULAR LAYER OF THE RIGHT FOOT.

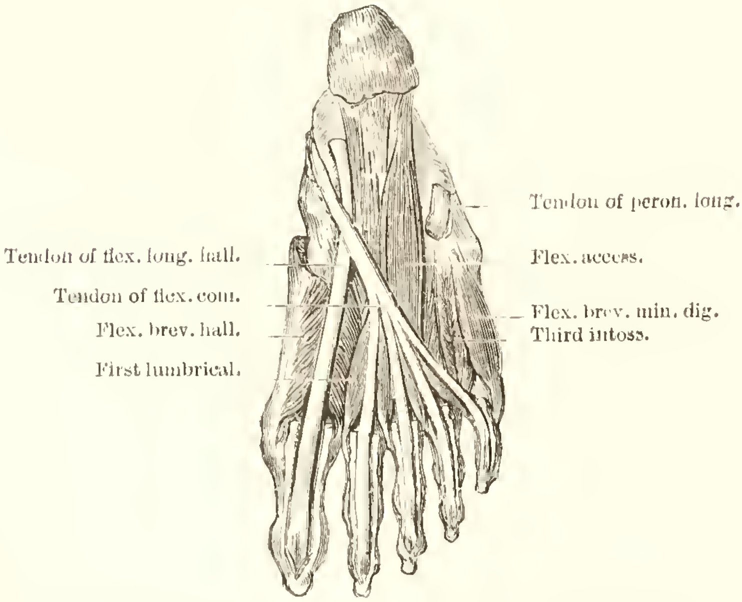


FIG. 374.—SECOND MUSCULAR LAYER OF RIGHT SOLE.

the sheaths themselves will be found to resemble those of the fingers, though they are less strongly marked.

Actions.—The action of this muscle has been given in the dissection of the back of the leg, and it will be further alluded to when speaking of the flexor accessorius.

The **Lumbricales** are four small muscles accessory to the tendons of the long flexor. Excepting the most internal, each *arises* from *two* tendons. The innermost arises from the inner side of the innermost tendon, viz. that for the second toe. They terminate in tendons which pass on the *inner* side of each of the four *outer* toes, and are *inserted* into the inner or tibial side of the bases of the metatarsal phalanges of the four outer toes, sending an expansion to the long extensor. The outer muscles are smaller than the inner.

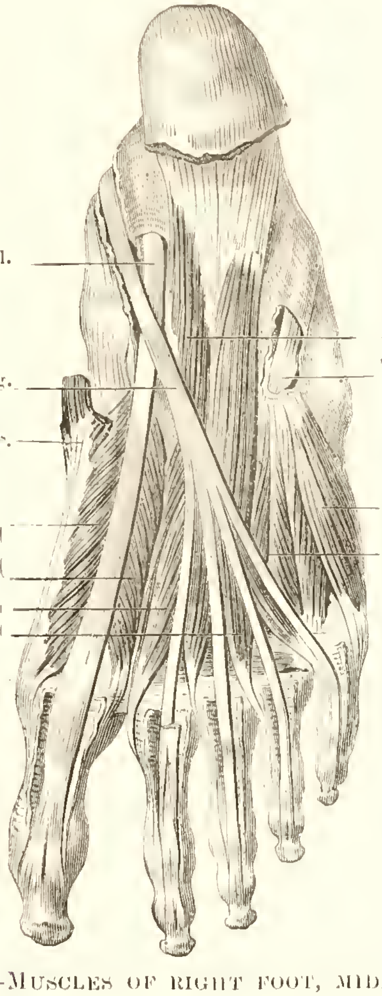


FIG. 375.—MUSCLES OF RIGHT FOOT, MIDDLE LAYER.

Actions.—They assist the flexors in bending the metatarso-phalangeal joints of the four lesser toes, but the tendons from which they arise must be fixed before they contract.

Nerves.—The two inner are supplied by the internal plantar, and the two outer by the external.

The **Flexor Accessorius** *arises* by two heads which are separated by the long plantar ligament; the *inner or larger* head is muscular, and is fixed to the inner concave surface of the os calcis and to the calcaneo-scaphoid ligament. The *outer* head is flat and tendinous, and arises from the under

surface of the os calcis in front of its outer tubercle, and from the long plantar ligament. These two heads join at an acute angle, and are *inserted* by aponeurotic bands into the outer margin and upper and under surfaces of the flexor longus digitorum, forming a sort of groove in which the tendon lodges. Slips from this muscle pass to the second, third, and fourth tendons of the flexor longus.

Relations.—*Above* it are the muscles of the superficial layer, separated by the external plantar vessels and nerves. *Beneath* and *between* it is the long calcaneo-scaphoid ligament.

Action.—From its position behind and to the outer side of the long flexor it opposes the directly inward action of that muscle, and assists it and the flexor brevis in flexing the toes directly backwards.

The **tendon of the flexor longus pollicis** is placed deeper in the sole than that of the digitorum. It is joined by a strong tendinous process of

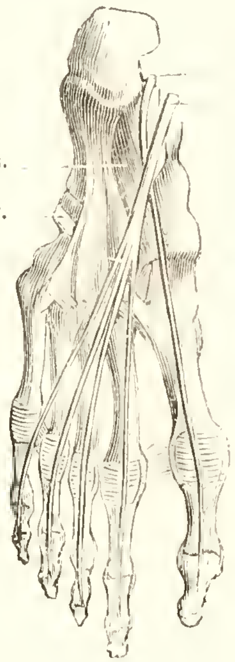


FIG. 376.—RELATIONS OF THE FLEXOR TENDONS TO EACH OTHER. LEFT FOOT.

the flexor longus digitorum, and passes forwards between the two heads of the flexor brevis pollicis, and is *inserted* into the base of the last phalanx of the great toe. Between the os calcis and inner malleolus it lies in a groove in the astragalus and below the sustentaculum tali of the os calcis, being sheathed by a synovial membrane. A tendinous process from the flexor longus pollicis to the flexor longus digitorum is joined by bands from the flexor accessorius, and passes to the tendons of the long flexor which go to the second and third toes, consequently it may bend these two digits and the great toe.

Dissection.—Divide the accessorius and the tendons of the long flexors near the os calcis, and throw them forward; remove the connective tissue from the third layer of muscles, being careful of two nervous filaments from the external plantar to the two outer lumbricales. The deep parts of the external plantar nerve and artery should also be cleaned.

Third Layer of Muscles.—There are four muscles in this layer belong-

ing to the big and little toes; three of them act upon the great toe and one on the little. Between the abductor pollicis, which is the middle muscle, and the flexor brevis minimi digiti on the inner side, will be found the interossei muscles of the next layer. It will be noted that three of these muscles run longitudinally, and one, the transversus pedis, passes across the foot at the roots of the toes.

The **Flexor Brevis Pollicis, or Hallucis,** is pointed and tendinous behind, *arising* from the inner border and under part of the cuboid bone and from the contiguous part of the external cuneiform; also from the part of the tibialis posticus tendon which is attached to that bone. It bifurcates in front and allows of the passage of the long flexor between its heads of *insertion*, which are attached to the outer and inner sides of the base of the first phalanx of the great toe, a sesamoid bone being found in each

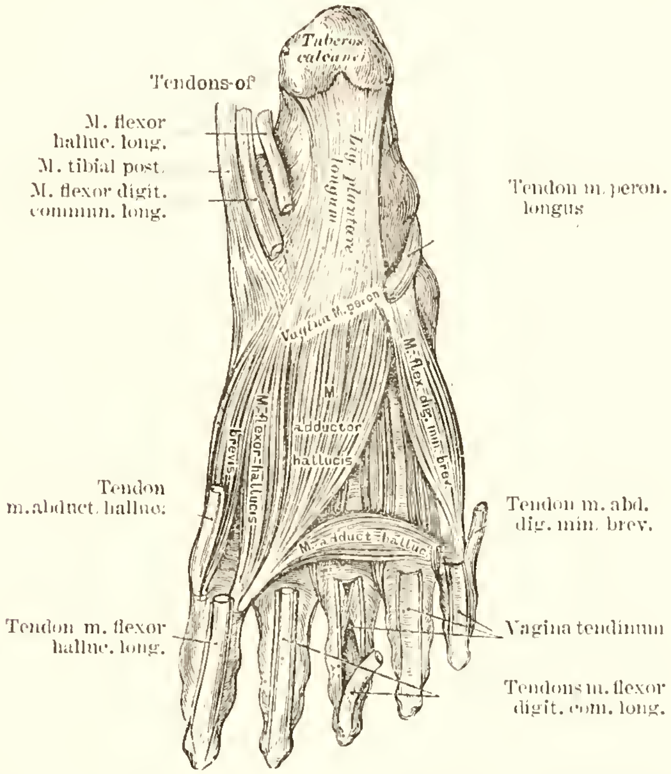


FIG. 377.—THE THIRD MUSCULAR LAYER OF THE RIGHT FOOT.

tendon at its insertion. The inner head blends with the abductor pollicis, and the outer with the adductor.

Relations.—*Above* it are the abductor pollicis, the tendon of the long flexor of the toe, and the inner piece of the plantar fascia; *beneath* it are the tendon of the peroneus longus and metatarsal bone of the great toe; *outside* is the abductor pollicis; and *inside* the adductor.

Actions.—It flexes the metatarso-phalangeal joint of the big toe.

Nerve.—The internal plantar, and occasionally a branch from the external plantar.

The **Adductor Hallucis Pollicis** is external to the preceding muscle, and is a large thickish fleshy mass, occupying the space between the four outer metatarsal bones, and crossing the foot obliquely. It *arises* from the sheath of the peroneus longus and from the tarsal ends of the second,

third, and fourth metatarsal bones, and is *inserted* with the outer head of the flexor brevis pollicis into the *outer* side of the base of the first phalanx of the great toe.

Relations.—Beneath its outer border the external plantar vessels and nerves pass inwards, the flexor brevis pollicis being on its inner side.

Actions.—It adducts the great toe to the middle line of the foot, and assists in flexing the metatarso-phalangeal joint. If the big toe be fixed, it will render tense the sheath of the peroneus longus.

Nerve.—The external plantar.

Varieties.—A muscle occurring in apes, the *opponens hallucis*, is frequently found. It generally is a slip from the adductor hallucis, and is inserted into some part of the metatarsal bone of the great toe.

The **Flexor Brevis Minimi Digiti** must not be mistaken for one of the outer interossei which it resembles. It lies on the metatarsal bone of the

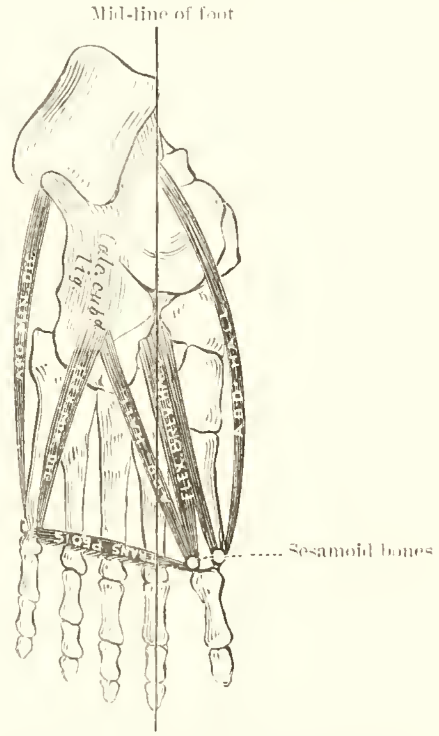


FIG. 378.—DIAGRAM OF MUSCLES OF LEFT FOOT.

little toe, and *arises* from the base of the metatarsal bone of that toe and from the sheath of the peroneus longus; passing forwards, it blends with the inferior ligament of the metatarso-phalangeal joint, and is *inserted* into the base of the proximal phalanx of the little toe on its *outer* side, and by some fleshy fibres into the anterior part of its metatarsal bone.

Relations.—*Superficial* to it are the abductor minimi digiti and plantar fascia; beneath it is the fifth metatarsal bone.

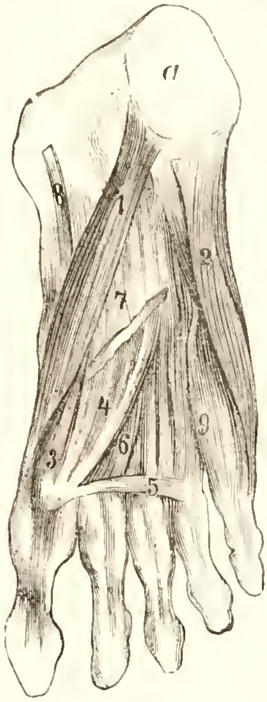
Actions.—It flexes the metatarso-phalangeal joint, and draws inwards and downwards the anterior part of the fifth metatarsal bone.

Nerve.—The external plantar.

Varieties.—A small muscle which appears to be a slip of the flexor brevis of the little toe (the *opponens minimi digiti*) is always united to it,

but is separately inserted into the inner side of the front half of the fifth metatarsal bone.

The **Transversus Pedis** passes transversely over the heads of the meta-



1. Abd. hall.
2. Abd. min. dig.
3. Flex. hall. brev.
4. Add. hall.
5. Trans. pedis.
6. Plantar intoss.
7. Tend. peron. long.
8. Tend. tib. post.
9. Flex. min. dig. The long plantar lig. and sheath of peron. long have been cut

FIG. 379.—DEEP PLANTAR MUSCLES OF RIGHT FOOT. ONE-THIRD.

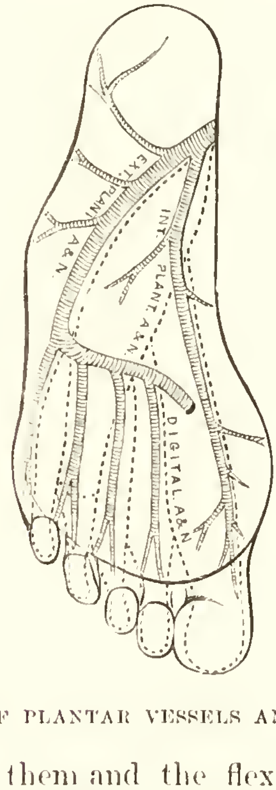


FIG. 380.—DIAGRAM OF PLANTAR VESSELS AND NERVES. LEFT FOOT.

tarsal bones lying between them and the flexor tendon. It is a narrow flat muscular fasciculus which *arises* by fleshy fibres from the under surface of the capsule of the metacarpo-phalangeal articulations of the four

outer toes. The slip from the smallest toe is often not present. It also arises from the fascia covering the interossei, and from the transverse ligament of the metatarsus. It is *inserted* with the adductor pollicis into the outer side of the first phalanx of the great toe.

Relations.—Its *deep* or *upper* surface is in contact with the interossei and the digital vessels; its *cutaneous* surface is in relation with the long and short flexor tendons, the lumbricales, and the digital nerves.

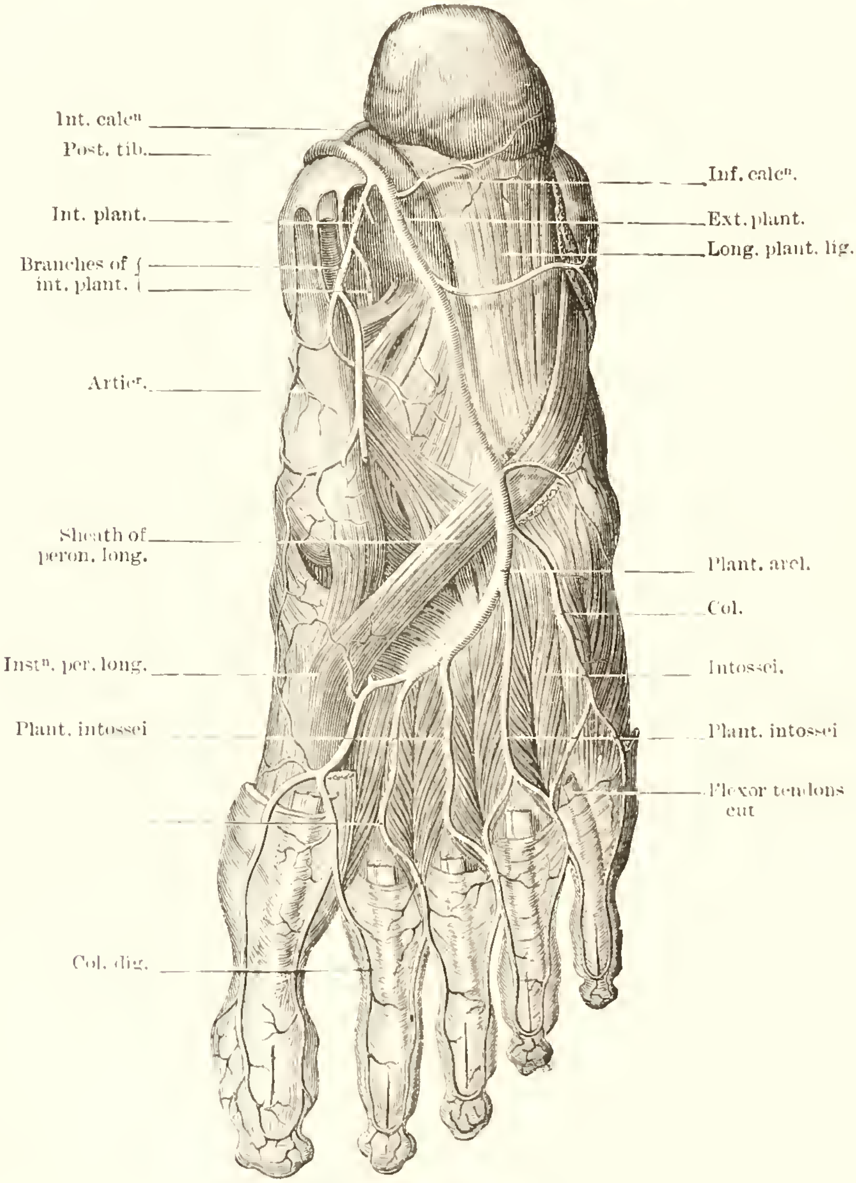


FIG. 381.—THE RIGHT PLANTAR ARCH.

Action.—It abducts the great toe and approximates the others.

Nerve.—The external plantar.

Varieties.—It may be absent, or the slip from the little toe or some of the other slips may be wanting.

Dissection.—To bring into view the deep vessels and nerves and the four layers of muscles, the adductor and flexor brevis pollicis are to be divided posteriorly and thrown forwards, noting the vessels and nerves

which supply them. The deep parts of the external plantar artery and nerve are to be cleaned, and the artery traced to the first interosseous space to its junction with the communicating branch of the dorsalis pedis. These and the interossei muscles must be cleaned, and the intervals between the latter defined.

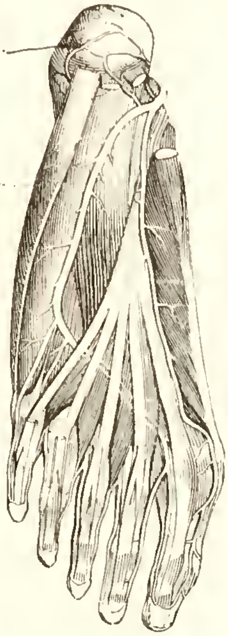


FIG. 382.—LEFT PLANTAR ARTERIES. SUPERFICIAL VIEW.

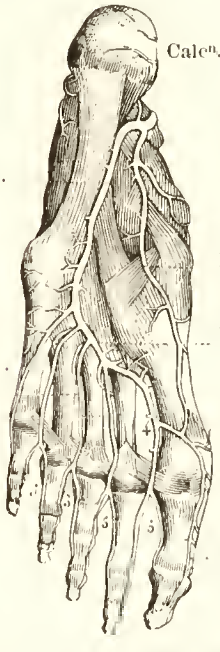


FIG. 383.—LEFT PLANTAR ARTERIES. DEEPER VIEW.

5 5 5. Digitals.

The **Plantar Arch** extends from the base of the fifth metatarsal bone to the back of the fifth interosseous space, where it is completed by the communicating branch from the dorsal artery of the foot. Venæ comites and the external plantar nerve accompany it. This part of the external

plantar artery lies deeply between the bases of the metatarsal bones, in contact with the interossei, and beneath the adductor pollicis. It gives several branches to these muscles.

Branches.—The *posterior perforating* are three small branches which are given off from the upper part of the arch and ascend through the back of the three outer metatarsal spaces to the dorsum of the foot between the heads of the dorsal interossei to anastomose with the dorsal interosseous branches of the metatarsal artery.

Varieties.—These perforating arteries are occasionally enlarged, and then give off the interosseous arteries of the dorsum of the foot; in this event, the metatarsal artery, from which the dorsal interossei generally come, is very small.

The *digital Branches* are four, and are given off from the front or convexity of the arch, and supply both sides of the three outer toes, and half

a. Tuberosity of os calcis.
b. Scaphoid and end of calcaneo-scaphoid lig.
a to *c*. Calc.-cuboid lig.
d. Its deep part.
e. Scapho-cuneiform.
f. A sesamoid of great toe.
6, 7, 8, 9 rest on the ant^{r}. transverse metatarsal ligt^{s}.
1. Post. tib^{l}.
2, 2′. Ext. plant.
2″. Plant. arch joining dorsalis pedis.
3, 3′. Int. plant.
3″. Its anast^{s}. with int^{l}. dig.
4. Branches of int. plantar.
5, 5′. First or ext. dig.
6, 7, 8, 9, and 10. Digitals. The post^{r}. perft^{g}. from the intoss. arteries are partly shown near the plantar arch. The anterior perf^{g}. are situated near 6′, 7′, and 8.
11 and 12. Calcanean branches of plantar and post^{r}. peroneal.

FIG. 384.—RIGHT PLANTAR ARCH AND BRANCHES AND LIGAMENTS OF SOLE.

of the second toe. The branch to the outer side of the little toe is single and is given off from the outer side of the plantar arch, passing beneath the abductor and flexor brevis minimi digiti. The others run beneath the transversus pedis and over the interossei of the three outer metatarsal spaces, and on reaching the interdigital clefts divide into *collateral* branches which supply the adjoining sides of the three outer toes and the outer side of the second. They supply the transversalis pedis, interossei, and outer lumbricales, and at the point of bifurcation send small communicating branches, the *anterior perforating*, to join the digital branches of the dorsal interossei from the metatarsal artery. The last two digitals anastomose with branches of the internal plantar at the roots of the toes.

The dissector will observe the resemblance of these vessels to those in

the hand. They extend to the end of the phalanx, where, like the corresponding nerves, they end in a small arch which gives offsets to the sides and ball of the toe and to the bed of the nail. The vessel to the second toe joins a branch from the dorsalis pedis. They form loops beneath the flexor tendons near the fronts of the proximal and middle phalanges, and supply the phalangeal articulations.

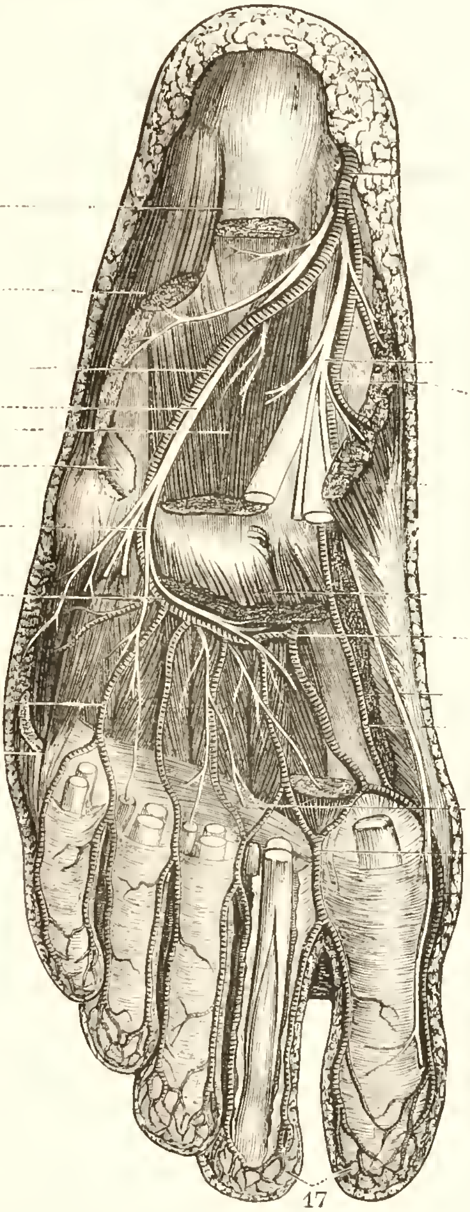


FIG. 385.—DEEP DISSECTION OF THE LEFT SOLE.

The tendinous sheath is laid open on the second toe. 17. Anastomoses of digitals. The plantar interossei muscles are shown.

The student will note from this description that, in the sole, the plantar arch supplies both sides of the three outer toes and the outer sides of the second; the inner side of the second and both sides of the great toe being supplied by the communicating and hallucis branches of the dorsalis pedis. The external plantar artery is the larger, and supplies both sides of the three outer toes and the outer side of the second. The

internal plantar nerve, which is the larger, supplies the three inner toes and the inner side of the fourth.

The **Dorsalis Pedis** artery, the continuation of the anterior tibial, enters the sole at the back of the first metatarsal interosseous space, where it divides into two branches which have been dissected with the sole of the foot. It inosculates by its communicating branch with the plantar arch. It resembles the radial artery in the hand, being distributed to one digit and a half, viz. by a large digital to both sides of the great toe and half the next.

The *digital branch, or dorsalis pollicis or hallucis*, passes along the outer border of the first metatarsal bone to the first interosseous space, and divides into two branches, of which one passes inwards beneath the tendon of the extensor proprius pollicis to the inner border of the great

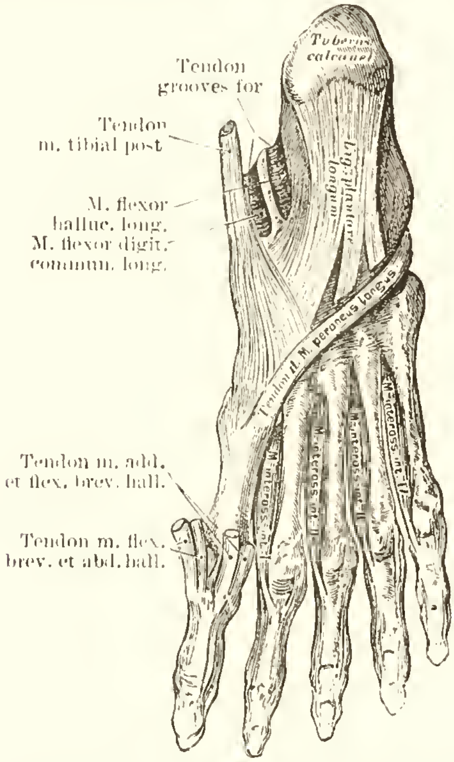


FIG. 386.—DISSECTION TO SHOW THE PLANTAR INTEROSSEI AND INSERTION OF THE DEEP TENDONS.

toe; another divides at the web between the great and next toe, to supply the adjoining sides of the toes. These vessels are of similar arrangement to the other digital branches along the toes, and the second digital inosculates at the end of the toe with the branch from the anterior tibial and that from the plantar arch.

Nerves.—**External Plantar Nerve.**—The deep branch of this nerve accompanies the deep part of the external plantar artery, and terminates internally to the adductor pollicis. It supplies all the interossei, except the fourth, the two outer lumbricales, the adductor pollicis, and the transversalis pedis. It sends some articular filaments to the tarsal articulations, and closely resembles in its distribution the ulna nerve in the hand.

Dissection.—Remove the transversalis pedis, and clean the ligament passing across the heads of the metatarsal bones.

The *transverse metatarsal ligament* is a strongish fibrous band resembling that in the hand, and connecting together the heads of the metatarsal bones. To its posterior edge are connected a thin fascia covering the interossei muscles, the tendons of the flexor longus and brevis digitorum, and longus pollicis. The digital nerves and the transversalis pedis conceal it.

Directions.—Reflect the flexor brevis minimi digiti by dividing it near its middle, and divide the transverse metatarsal ligament between the bones; separate the interossei muscles, remove the fascia covering them, and dissect out the muscular branches of the external plantar nerve.

Fourth Layer of Muscles.—In this layer are found the interossei and the tendons of the tibialis posticus and peroneus longus.

The *Pedal Interossei* muscles resemble those in the hand, with this exception, that in the hand they are arranged around the middle line of

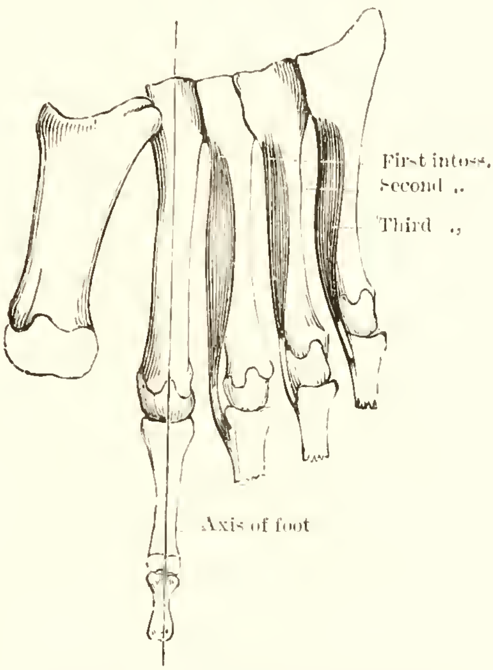


FIG. 387.—PLANTAR INTEROSSEI OF RIGHT FOOT.

the whole member; while in the foot they are grouped around the second toe which is taken as the mid-line. They are placed in the interval between the metatarsal bones, and are seven in number, consisting of two sets—three palmar, and four dorsal, which are the larger, two being found in each space except the innermost, which lacks a plantar interosseous muscle.

The **Plantar Interossei** are placed beneath and between the three outer metatarsal bones. They are slender, single, fleshy slips, being connected with but one metatarsal bone, and *arise* from the bases, inner sides, and under surfaces of the shafts of the third, fourth, and fifth metatarsal bones, and are *inserted* into the *inner* or tibial sides of the bases of the first phalanges of the same toes, and partly by an expansion to the aponeurosis of the common extensor. These muscles are smaller than the dorsal, are placed more in the sole of the foot, and are all *adductors* towards the mid-line of the second toe.

Action.—They approximate the three outer toes to the second toe.

The *Dorsal Interossei* are four in number, and are placed between the metatarsal bones, *arising* by two heads in a bipenniform manner from the lateral surfaces of the metatarsal bones between which they are placed. Their tendons are, like the plantar interossei, *inserted* into the sides and dorsum of the first phalanges in the following way. The inner two dorsal interossei are attached to the second toe, one on each side; the next is inserted to the outer side of the third toe; and the other to the outer side of the fourth.

Relations.—The plantar muscles are crossed by the external plantar artery and nerve, and their digital branches, and lie beneath the transversalis pedis and the metatarsal ligament. The angular interval at the posterior extremity of the double origin of each of the dorsal interossei (except the first through which the communicating branch of the dorsalis

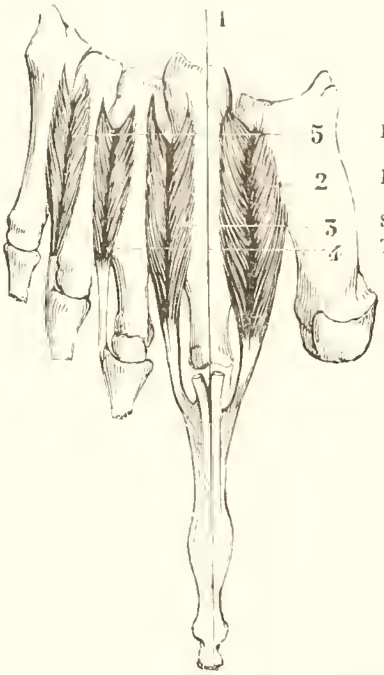


FIG. 388.—DORSAL INTEROSSEI OF RIGHT FOOT.

pedis joins the external plantar) is pierced by the posterior perforating arteries from the plantar arch which join the interosseous branches of the metatarsal.

Actions.—The dorsal interossei are *abductors* from the mid-line of the second toe. The two dorsal interossei connected with the second toe will move it to the inner or outer side of that line.

Dissection.—Trace the **tendon of the tibialis posticus** to its insertion, and dissect out its various processes backwards to the os calcis, forwards to the middle and external cuneiform, and outwards to the cuboid and bases of the third and fourth metatarsal bones. This is the largest of these processes. Lay open the fibrous sheath of the peroneus longus, and trace it to its insertion. The student will note that tendinous bands of the tibialis posticus are connected with all the tarsal bones except the astragalus, and with all the metatarsal bones except the first and fifth. Where

the tendon passes beneath the astragalus it contains a *fibro-cartilage* or *sesamoid* bone, and a process from it passes back to the margin of the groove in the os calcis for the tendon of the flexor longus pollicis.

The **tendon of the peroneus longus** will be found in a fibro-osseous canal of the cuboid lined by a separate synovial membrane, and will be observed to pass inwards to the groove on the under surface to be inserted on the outer surface of the internal cuneiform bone and base of the metatarsal of the great toe, and sometimes it sends a slip into the base of the second metatarsal. As the tendon of the peroneus longus passes underneath the cuboid it becomes thickened, and contains a *fibro-cartilage* or a *sesamoid* bone. The sheath of the peroneus longus is crossed at its outer portion

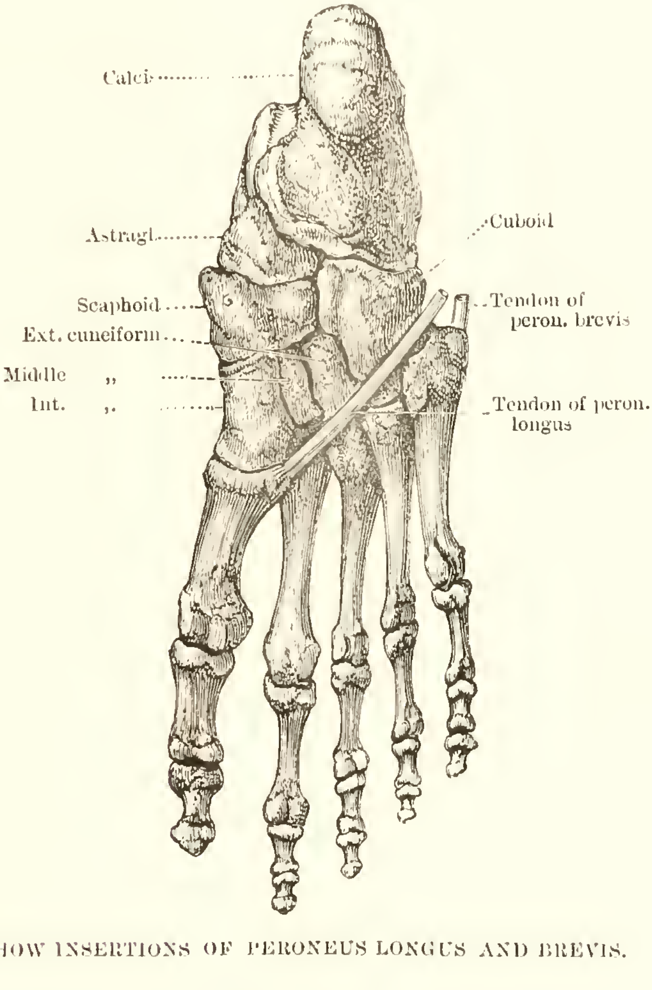


FIG. 389.—TO SHOW INSERTIONS OF PERONEUS LONGUS AND BREVIS. PLANTAR ASPECT.

by a part of the long plantar ligament which passes to the tarsal ends of the third and fourth metatarsal bones. Internally, this sheath consists only of areolar tissue, and it is lined by a separate synovial membrane.

Another method of dissecting the foot.—If the student be dissecting the foot for the second time I can recommend the following plan, which preserves the relations of the parts and is therefore very useful for making museum preparations. After reflecting the skin and subcutaneous fatty tissue, the three partitions, middle, outer, and inner of the sole, should be separately opened in the mid-line of each space, and their contents made out. Then a thin layer of the os calcis, having attached to it the flexor

brevis digitorum, should be sawn off and thrown towards the toes by dividing the internal attachments of the middle piece of the plantar fascia.

A second slice should now be removed from the os calcis, having attached to it the origin of the abductor hallucis, and reflected. Then divide the tendons of the flexor longus digitorum and flexor longus hallucis about two inches above the internal malleolus, and pull them down and out of their sheaths, and reflect them sufficiently to expose the underlying structures, which should be cleaned. After preparing the digital vessels and nerves, and the insertion of the interossei and lumbricales, the adductor hallucis may be divided and reflected to expose the plantar arch and nerves, and the deepest muscles, and the parts being replaced in their natural positions may be preserved and serve for the demonstration of the structures in the sole, layer by layer. The cut ends of the tendons may be stitched together, and the pieces of the os calcis may be fastened with strong pins.

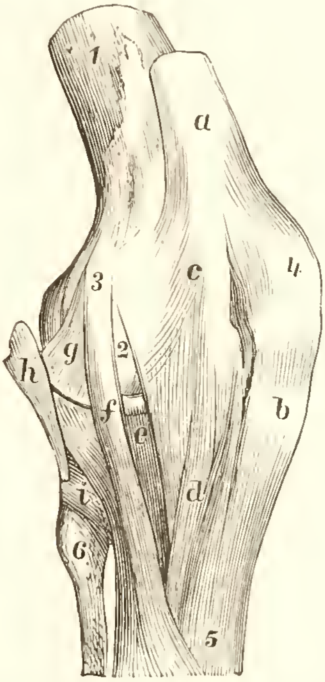
THE KNEE JOINT.

Dissection.—Remove the muscles and tendons from around the joint, noticing any prolongations from them, and clean away any connective or fibrous tissue which conceals the ligamentous bands. Define the capsule which passes between the various ligaments. The tendons of the biceps, semimembranosus, popliteus, and adductor magnus should be left undisturbed. The joint should be submitted to flexion, extension, and rotation, to see which of the extra-articular ligaments are stretched or otherwise.

FIG. 390.—INTERNAL ASPECT OF LEFT KNEE.

The knee is the largest joint in the body, and is a ginglymus or hinge joint. The condyles of the femur above, the patella in front, and the upper surface of the head of the tibia below, enter into its formation. The articular surfaces are covered with cartilage and connected by ligaments, some of which are extra-articular, whilst others are within the joint. The external, or *extra-articular* ligaments, are the anterior, or ligamentum patellæ; the posterior, or ligamentum Winslowii, the internal lateral, two external lateral, and the capsular. The internal or *intra-articular* ligaments,

are the anterior or external crucial, the posterior or internal crucial, the semilunar fibro-cartilages, the transverse, the coronary, the ligamentum mucosum, and ligamenta alaria, which latter are processes of the synovial membrane. The *anterior ligament* (ligamentum patellæ) is the lower part of the tendon of insertion of the extensor muscles of the thigh. It is from two to three inches long, and is fixed above to the apex of the patella and to a rough depression on the posterior surface of the apex. Below it is inserted into the lower part of the tibial tuberosity and to an inch of the bone below it. It passes obliquely down and out to its insertion. It is strong, flat, and ligamentous, and its superficial fibres pass over the front of the patella to be continuous with those of the quadriceps extensor aponeurosis. There is a synovial bursa between the patella and the skin, and another between the upper part of the tuberosity of the tibia and the back of the ligament. Its lateral margins are continuous with the capsular ligament, and with the aponeuroses of the vasti. The posterior aspect of this liga-



1. Femur.
2. External condyle.
3. Epicondyle or ext. tuberty.
4. Patella.
5. Tibial crest.
6. Fibular head.
a. Quadriceps tendon.
b. Lig. patellæ.
c d. Expansion of quadriceps tendon on lateral patellar lig.
e. Edge of ext. semilunar meniscus.
f. Part of ilio-tibial band of fascia lata.
g. Short. ext. lat. lig.
h. Biceps tendon.
i. Capsular lig. of sup. tib.-fib. joint.

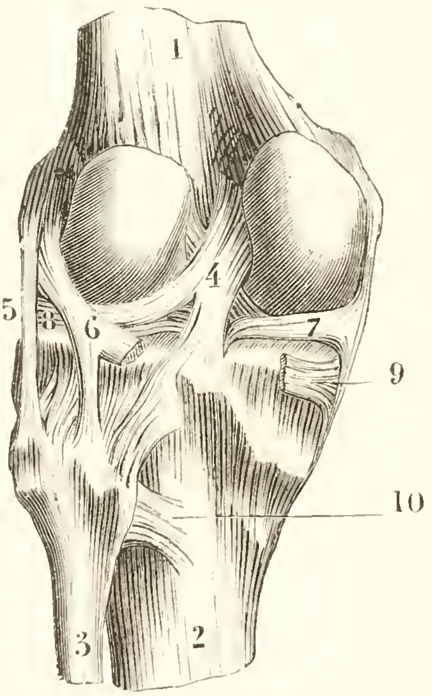
FIG. 391.—RIGHT KNEE JOINT. ANTERO-EXTERNAL VIEW. ONE-THIRD.

ment is in relation with a mass of peri-articular fat which being below the patella is called the 'infra-patellar mass.' It is the larger of the two peri-articular fatty cushions, and fills the interval between the head of the tibia and the anterior ligament, which it separates at its upper part from the knee joint. This *infra-patellar* fatty mass is the largest, and gives origin to the folds of the synovial membrane, and from it a narrow piece passes on either side round the patella. The piece on the inner margin is the larger, and overhangs the perpendicular inner facet. In extension of the knee this pad is applied to, and lubricates, the condyles.

The *supra-patellar* pad of fat will have been noticed in reflecting the quadriceps extensor. It is placed between the femur and that muscle and around the upper part of the supra-patellar process of synovial membrane. It is larger on the outer than the inner side. There is also some fat around the crucial ligaments in the interior of the joint.

The *posterior ligament* (ligamentum posticum Winslowii) is wide and fibrous, and is formed partly by a process of the tendon of the semimembranosus. It consists of a central and two lateral parts. The *central* portion is composed of fasciculi which obliquely intercross, and are pierced by the posterior articular vessels and nerves. The strongest of these fasciculi passes opposite the intercondyloid notch, and is formed from that part of the tendon of the semimembranosus which passes from the back of the inner tuberosity of the tibia obliquely up and out to the back of the outer condyle. The *lateral* portions are formed mainly of vertical fibres which pass from the upper parts of the condyles to the back of the articular surfaces of the head of the tibia. They are closely united with the tendons of the gastrocnemius, popliteus, and plantaris. This ligament forms part of the floor of the popliteal space, the popliteal artery resting on it.

The *Internal Lateral Ligament* is a strongish, broad, flat fibrous band, thicker behind than in front, and placed nearer the back than the front of



1. Femur.
2. Tibia.
3. Fibula.
4. Postr. crucial.
5. Long. ext. lat.
6. Tend. of popliteus, and below it is short ext. lat. lig.
7. Int. fibro-cartilage.
8. Ext. „
9. Tend. of semimemb.
10. Postr. supr. tib.-fibr.

FIG. 392.—CRUCIAL AND EXTERNAL LATERAL LIGAMENTS OF LEFT KNEE.

the joint. It is fixed to the inner tuberosity of the femur above, where it blends with the capsule, and below to the inner margin of the internal tuberosity of the tibia and inner surface of the shaft for nearly two inches. It is inserted below the level of the anterior ligament where it becomes thicker. Tendinous expansions from the sartorius, gracilis, and semimembranosus pass *over* the ligament, being separated from it by a synovial bursa. Passing *beneath* it are the inferior articular vessels and nerves, the anterior portion of the tendon of the semimembranosus and the synovial membrane. It is closely adherent to the convex border of the internal semilunar fibro-cartilage. Its *posterior* edge is strengthened by some fibres of the semimembranosus, and opposite the tibial head it is separated from the capsule.

Directions.—The dissector should partly divide this ligament to trace

the insertion of the semimembranosus beneath it, noting a bursa between the tendon and the bone. He must define the oblique process of this tendon to the posterior ligament, the membranous prolongation from its lower border over the popliteus, and the fibres from it to the posterior edge of the internal lateral ligament.

The *Long External Lateral Ligament* is a strong rounded fibrous structure, placed like the internal lateral and crucial ligaments, nearer the back than the front of the joint. Above it is attached to the outer tuberosity of the femur; below to the outer head of the gastrocnemius, and it descends vertically between the division of the biceps tendon to a depression on the outer part of the head of the fibula. The biceps tendon is in relation to its *outer* surface, and the tendon of the popliteus and the inferior external articular vessels and nerve pass beneath it on its *inner* side.

The *Short External Lateral Ligament* is sometimes to be found, and when present is accessory to the long ligament. It is posterior to and parallel with the long ligament, and is sometimes attached above to the

1. Femur.
2. Tibia.
3. Fibula.
4. Post^{r}. lig.
5. Semimemb. tendon.
6. Ant. band } of semimemb. tendon.
7. Inf. „
8. Ext. „
9. Bursa.
10. „ opened
11. Tendon of popt^{s}.
12. Synovial pouch.
13. Outer head of gastroc.
14. Biceps.

FIG. 393.—POSTERIOR ASPECT OF LEFT KNEE JOINT.

lower part of the external tuberosity of the femur, but is frequently not connected with that bone, but with the outer tendon of the gastrocnemius. It is inserted into the tip of the styloid process of the fibula. It is closely connected with the capsular ligament, and passing beneath it is the tendon of the popliteus and the inferior external articular vessels and nerve.

Directions.—The student should define the two pieces into which the biceps tendon divides, and note a prolongation from the anterior of these to the outer tuberosity of the tibia. He should then study the attachments of the capsular ligament, and this being done, must divide it to follow out the tendon of the popliteus.

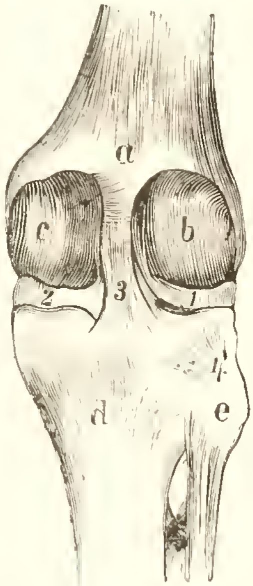
The *Capsular Ligament* is very thin, but is a strong, partly fibrous and partly ligamentous membrane, which fills in the spaces between the preceding ligaments and encloses the synovial membrane. It is fixed to

the femur just above its articular surface; in front to the borders and sides of the patella; and below to the margins of the tibial head and interarticular fibro-cartilages, blending with the coronary ligaments;

1. Femur.
2. Tibia.
3. Fibula.
a. Tend. of add. mag.
b. Int. head of gastroc.
c. Ext. „ „ a bursa beneath each opened.
d. Tend. of semimemb.
e. Anterior, *f.* Inferior, *g.* Posterior } bands of semimemb. tendon.
h. Poplt^s. expansion.
i. Accessory band.
k. Short ext. lat.
l. Long „
m. Post^r. sup^r. tibio-fibular.
n. Tend. of soleus.
o. „ biceps.
p. Intoss. lig. showing aperture for ant. tib. a.

FIG. 394.—LIGAMENTS OF LEFT KNEE. POSTERIOR VIEW.

behind it blends with the posterior ligament which it helps to form. An aponeurotic expansion from the flexor and extensor tendons and from



a. Poplt^l. space.
b. Ext. condyle.
c. Int. „
d. Tibia.
e. Head of fibula.
1. Ext. fibro-cartilage.
2. Int. „
3. Accessory lig. to post. crucial.
4. Post^r. sup^r. tib.-fib^r.
5. Intoss. ligt.

FIG. 395.—RIGHT KNEE JOINT IN EXTENSION. POSTERIOR VIEW.

the fascia lata considerably strengthens this ligament in front and at the sides. It covers the anterior and external lateral ligaments and joins the internal, and is not intimately adherent to the synovial membrane. At

its outer and back part the capsule is pierced by the tendon of the popliteus.

The *Tendon of Origin of the Popliteus Muscle* may now be traced out. It will be found to arise from the anterior part of an oblong depression on the external surface of the outer condyle. It then crosses the external fibro-cartilage and the back of the superior tibio-fibular joint. If the knee joint be now bent the tendon will be seen to occupy the groove on the condyle, but if it be extended the tendon will slip out of the groove.

The *Tendon of the Adductor Magnus* must be traced to its insertion

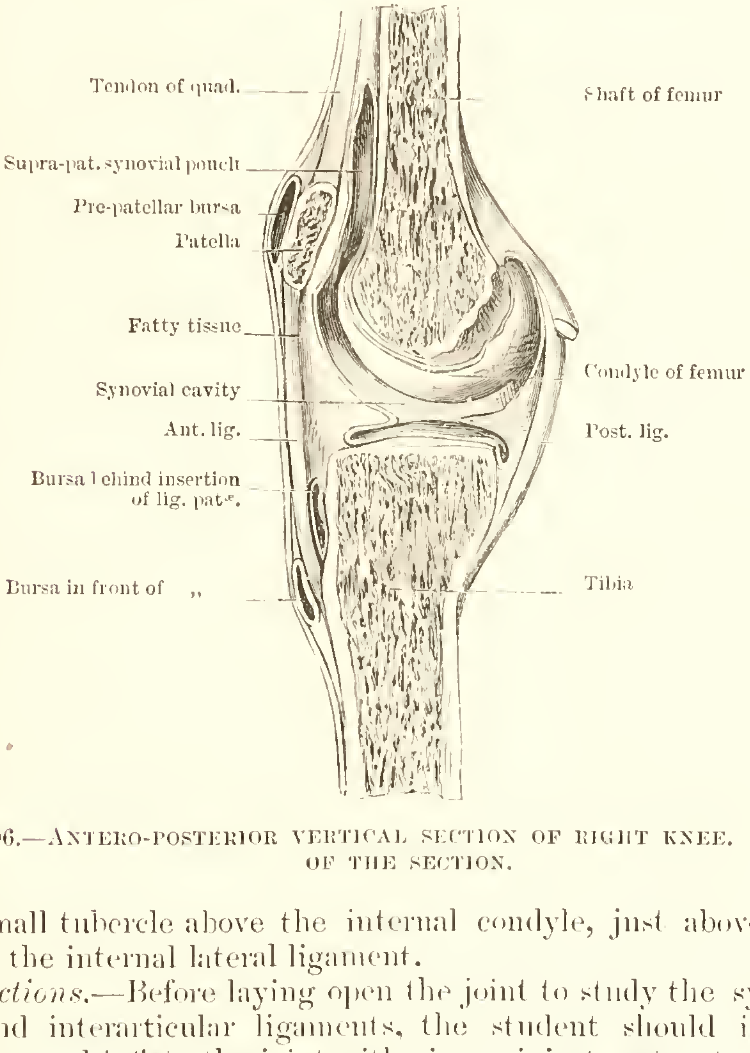


FIG. 396.—ANTERO-POSTERIOR VERTICAL SECTION OF RIGHT KNEE. OUTER PART OF THE SECTION.

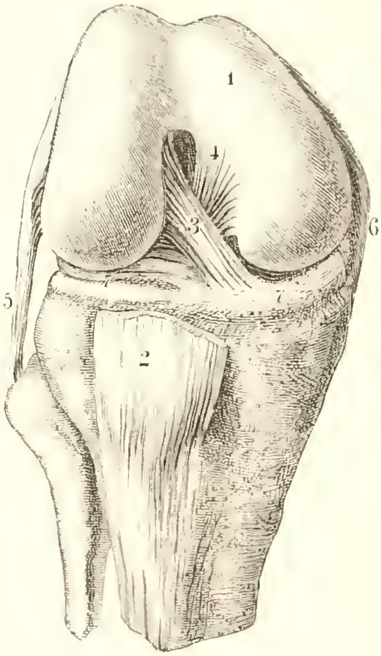
into a small tubercle above the internal condyle, just above the attachment of the internal lateral ligament.

Directions.—Before laying open the joint to study the synovial membrane and interarticular ligaments, the student should introduce the blow-pipe, and inflate the joint with air, or inject water, to see any processes of the synovial membrane which may project between the ligaments, and more especially through the posterior ligament. The pouches of the synovial membrane above and at the sides of the patella and over the back of the condyles will become distended, the ligamentum patellæ will be stretched, and the patella itself floated up. This condition of parts exists in effusion of serum or pus into the joint in synovitis.

Dissection.—Place a block in the popliteal space so as to raise and flex the knee, lay open the joint by an incision across it above the patella. This cut should extend to the back of the condyles. The patella and

anterior part of the capsule should be thrown down, and the synovial folds will become evident.

The *Synovial Membrane* of this joint is the most extensive in the body. It is attached to the margins of the cartilage covering the condyles, and has a large pouch beneath the extensor tendons. This cul-de-sac runs higher up on the inner than on the outer side, it then passes down to the upper border and sides of the patella, passing beneath the capsular ligament, and is separated from the anterior ligament below the patella by a large quantity of fat. At this spot it sends off a triangular process, which contains a few ligamentous fibres, to the front of the inter-condylar interval. This is the so-called *ligamentum mucosum*. Below and on each side of the patella are two fringe-like folds which pass from the sides of the ligamentum mucosum up, in, and out to the sides of the patella. The inner is more prolonged than the outer. The synovial membrane covers the semilunar cartilages on both surfaces, and at the



1. Femoral condyles.
2. Ant. lig. or lig. patellæ.
3. Ant. crucial.
4. Post. crucial.
5. Ext. lat. lig.
6. Int. lat. lig.
7. Int. fib. cart.
7'. Ext. ,,

FIG. 397.—CRUCIAL LIGAMENTS OF RIGHT KNEE. ANTERIOR ASPECT.

back of the external one forms a pouch between the tendon of the popliteus and the groove on its outer surface. It is continued over the articular surface of the tibia, surrounds the crucial ligaments and the internal surface of the extra-articular ligaments, and passing upwards forms two pouches on the backs of the outer and inner condyles. Into the *supra-patellar pouch* is inserted the subcrureus muscle which draws the pouch up in extension of the joint.

Directions.—The student should note the masses of fat above and below the patella, and some around the crucial ligaments. He must also clear away the infra-patellar mass of fat, being careful of the transverse ligament passing between the interarticular fibro-cartilages in front. The remains of the synovial membrane must be removed from the crucial ligaments and interarticular cartilages.

The posterior ligament should be turned towards the dissector and

should be carefully removed, the student noticing the synovial pouches above the condyles and the bands from the external fibro-cartilages in front and behind the posterior crucial ligament. The remaining intra-articular ligaments will now be exposed and cleaned. These are the two crucials, the two semilunar fibro-cartilages, the transverse, and the coronary. While studying these ligaments the student should move the joint in various directions so as to verify the statements made with regard to their tension and laxity in the different motions of which it is capable.

The *Crucial Ligaments* are two very strong inter-osseous fibrous cords passing from the upper surface of the tibia to the surfaces of the inter-condyloid notch. They are placed nearer the back than the front of the joint and cross each other, and have therefore been called *crucial*. These femoro-tibial ligaments are placed one in front of the other, and are called *anterior* and *posterior*.

The *Anterior or External Crucial Ligament* is smaller and more oblique than the posterior. It is attached above by its shorter posterior fibres into the inner and back part of the outer condyle of the femur, and

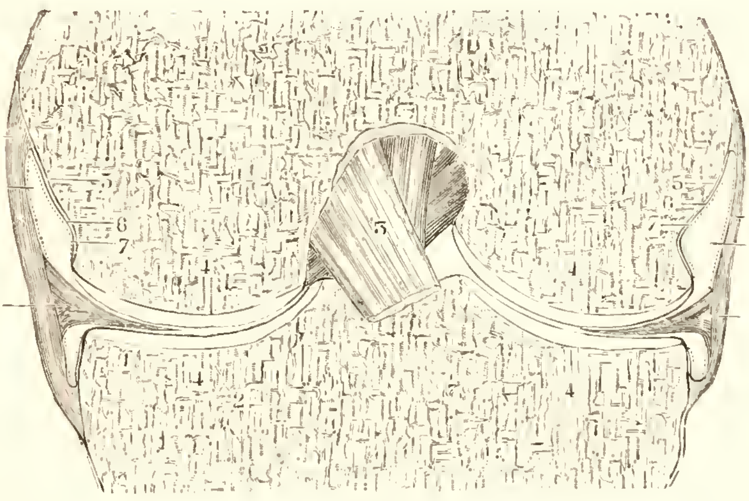


FIG. 398.—VERTICAL TRANSVERSE SECTION OF RIGHT KNEE IN EXTENSION; POSTERIOR PART OF THE SECTION SEEN FROM THE FRONT.

by its longer anterior fibres into the upper and hinder part of the inter-condyloid fossa; and below to the inner side of the depression in front of the tibial spine, close to the inner margin of the inner articular surface, reaching to the inner part of the spine, and being blended with the anterior end of the external semilunar fibro-cartilage.

The *Posterior or Internal Crucial Ligament* is larger and more vertical, and is fixed above by its posterior shorter fibres to the inner condyle alongside its oblique curvature, while its longer anterior fibres are attached to the outer and fore part of the inner condyle. From its anterior surface a fasciculus is given off which blends with the posterior part of the anterior crucial ligament. In front and behind this ligament are two processes of the external semilunar fibro-cartilage.

Actions.—The external ligaments having been cut through, the student, by moving the joint in various directions, will learn the use of

these internal ligaments; after having studied the anterior crucial ligament, cut it carefully across and leave the posterior entire. The *anterior* ligament checks *extreme extension and internal rotation*. This and the

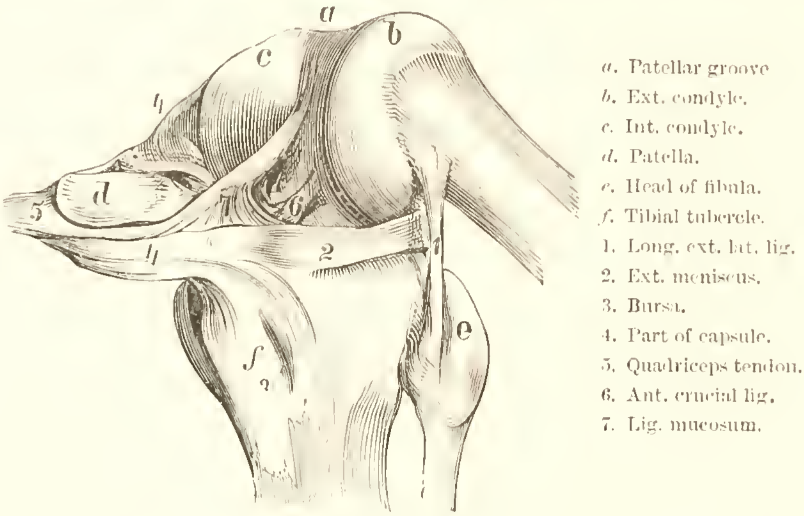


FIG. 399.—LEFT KNEE OPENED IN FLEXION. ANTERO-EXTERNAL VIEW. ONE-THIRD.

posterior ligament are connecting bands between the tibia and femur, and prevent the latter bone being carried too far backwards and forwards. If the anterior crucial be cut and the posterior be left intact, it will be found

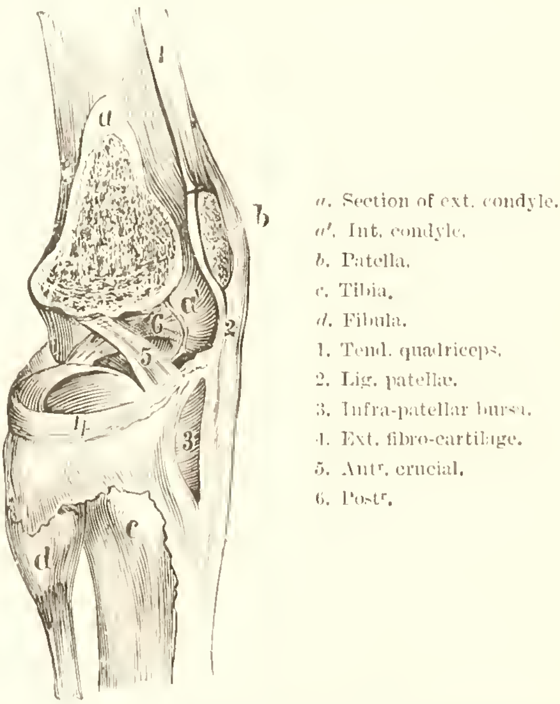
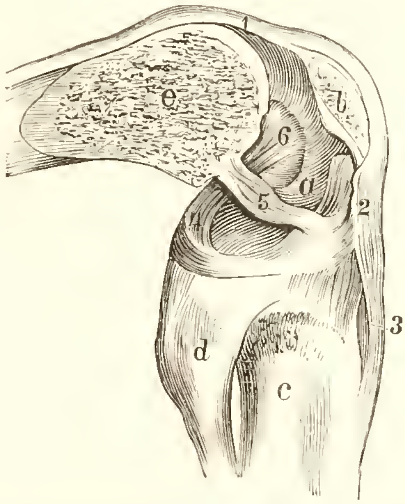


FIG. 400.—RIGHT KNEE IN EXTENSION. VERTICAL SECTION THROUGH THE OUTER CONDYLE AND PATELLA. ONE-THIRD.

that in the semiflexed state the tibia can be placed in front of the femur. The *posterior* crucial checks *extreme backward* movements of the tibia by the flexors or by force, and is rendered tense in *extreme flexion*. The

student will be able in another joint, in which the anterior crucial has not been cut, to observe that if the posterior be divided and the anterior left intact, the articular surfaces of the tibia can be passed nearly completely behind the condyles, although they cannot be moved further forwards than before it was divided. *External rotation* is not checked by either crucial, as they uncross, and will allow the tibia to be placed hind-foremost. Some anatomists state that the posterior ligament checks rotation out.

The *Inter-articular or Semilunar Fibro-cartilages* or *Menisci* are two laminæ which partly cover the articular tibial surface. They are triangular on section, the bases being thick and convex, and attached to the margins of the tibial head. The apices are thin, concave, and free Their upper surfaces are concave and in contact with the femoral condyles, their lower surfaces are flat and rest on the tibia. Each cartilage covers about the outer two-thirds of the corresponding articular surface of the tibia, leaving the rest of its articular surface uncovered, and both their



a. Int. condyle.
b. Patella.
c. Tibia.
d. Fibular head.
e. Ext. condyle.
1. Quadriceps tendon.
2. Lig. patellæ.
3. Bursa.
4. Ext. fibro-cartilage.
5. Ant. and
6. Posterior crucial ligaments.

FIG. 101.—RIGHT KNEE IN FLEXION. VERTICAL SECTION THROUGH THE OUTER CONDYLE AND PATELLA. ONE-THIRD.

surfaces are covered by the synovial membrane. They are fibrous at their tibial attachments and cartilaginous between the articular surfaces.

The *internal fibro-cartilage* is almost semicircular, being broader behind than in front, and somewhat elongated from before back Its convex margin is attached to the head of the tibia by the coronary ligament, and is united to the internal lateral ligament. It is fixed in front by a thin pointed process to a depression anterior to the inner articular surface of the tibia and in front of the anterior crucial ligament. Its posterior extremity is much wider, and is attached to the inner lip of the depression behind the tibial spine between the attachment of the posterior crucial and the hinder attachment of the external fibro-cartilage.

The *external fibro-cartilage* is nearly circular and covers a greater part of the articular surface than the internal. Its circumference is bound to the tibia by the coronary ligament, and its extremities are firmly fixed to the depressions in front and behind the tibial spine, being within the points of insertion of the internal fibro-cartilage. Its outer side is grooved by the tendon of the popliteus. Its anterior extremity is fixed

in front of the tibial spine, opposite the anterior crucial ligament, which it touches, and close to the inner margin of the outer articular surface; and its posterior end is fixed between and behind the two osseous points of the tibial spine. It is less closely joined to the capsule than the internal, as its anterior part is nearer the centre of the joint, and the tendon of the popliteus separates it behind from the capsular ligament. This fibro-cartilage has some accessory bands. The one given off from its *anterior border* is the *transverse ligament*. Its *posterior* extremity divides into

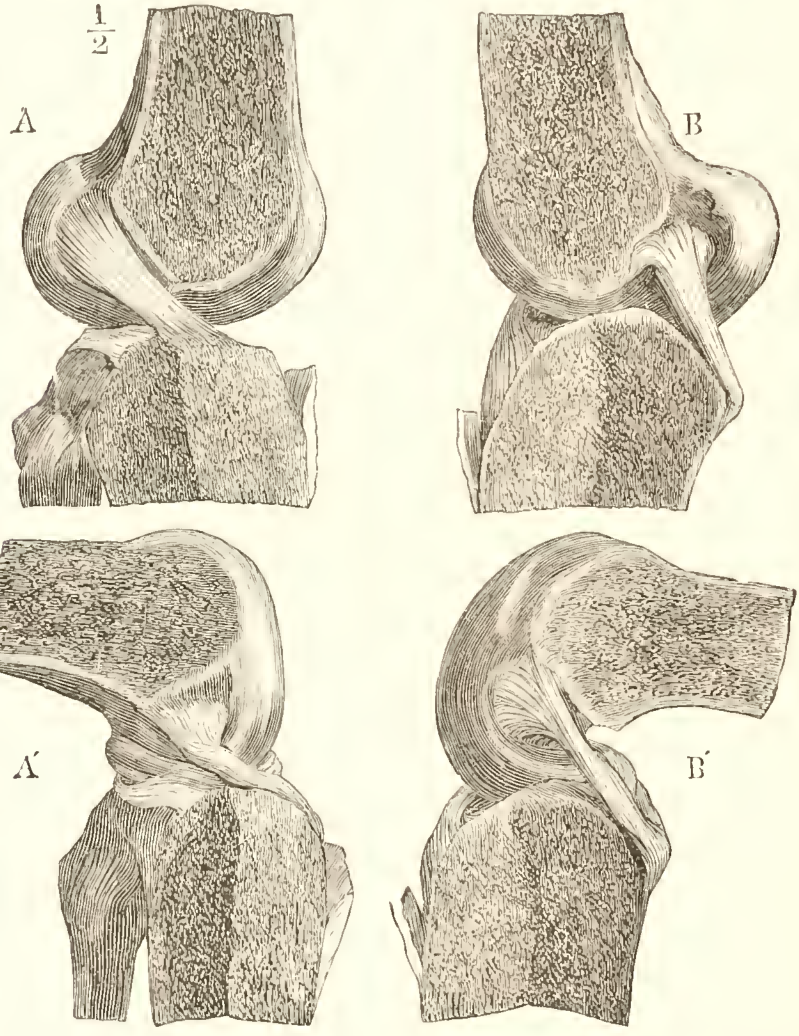


FIG. 402.—VERTICAL ANTERO-POSTERIOR SECTION OF THE KNEE JOINT TO SHOW THE ACTION OF THE CRUCIAL LIGAMENTS.

A, Anterior crucial in extension. A′. In flexion. B. Posterior crucial in extension. B′. In flexion.

two or three processes. Two of these pass forwards and upwards on either side of the posterior crucial to be inserted with it into the femur. The third fasciculus is inserted into the back of the anterior crucial ligament.

Use.—These structures deepen the hollows on the upper surface of the tibia for the reception of the femoral condyles, and fill the interval between the bones and the joint circumference. They act also as buffers in moderating pressure and in diminishing shocks. They move forwards and backwards with the tibia in extension and flexion. In the former motion

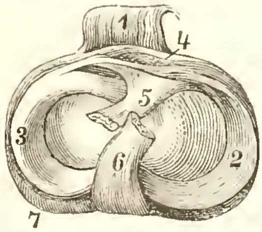
they are flattened on the tibial head, and in the latter they recede a little from the anterior part of the joint. The external cartilage, having its ends nearer together and being much less attached to the capsule, moves more than the internal. This is the more likely fibro-cartilage to be displaced, although cases are recorded in which the inner one has been dislocated. The fasciculi of the external fibro-cartilage serve to keep it (being the more movable) more firmly fixed. Its anterior fasciculus or the transverse ligament helps to keep the cartilage forwards in flexion, and the posterior fasciculi tend to prevent displacement of the back of the cartilage in rotation. In this latter motion these cartilages follow the movement of the tibia, but the external is more dislodged than the internal.

The *transverse ligament* is a fibrous band passing from the front margin of the external fibro-cartilage to the anterior end of the internal meniscus. Its strength varies in different subjects.

The *coronary ligaments* are short fibrous bands which join the convex borders of the fibro-cartilages with the circumference of the head of the tibia, and with the other extra-articular ligaments.

Joint Surfaces.—On the articular surface of the femur are facets for the tibia and the patella. The patellar facet is above the others in the mid-

1. Lig. patellæ.
2. Int. fibro-cartgᵉ.
3. Ext. ,,
4. Transverse.



5. Antʳ. crucial
6. Postʳ. ,, attached to ext. fibro-cartilage.
7. Tibia.

FIG. 403.—THE FIBRO-CARTILAGES OF THE LEFT KNEE RESTING ON THE TIBIA.

line, and is hollowed in the centre with a rounded sloping surface on each side, the outer being the larger.

The inner femoral condyle is curved at its anterior third, the concavity of the curve pointing outwards. This is called the *oblique curvature.* Very near to this curve is a semilunar surface which comes in contact with the perpendicular facet of the patella in extreme flexion. The portions of the condyles which come in contact with the tibia are separated from the patellar surface by an oblique curve on each side. On the centre of the end of each condyle is a flat portion which comes in contact with the tibia in standing. This is the *Pressure Facet.* At the posterior third of the condyles is a more convex part which comes in contact with the tibia in rotation.

The head of the tibia has two articular hollows which are deepened by the fibro-cartilages, the inner being the larger and deeper.

The cartilaginous surface of the patella has the following impressions. At its inner edge is a vertical narrow facet, and near the lower border is a transverse marking. The rest of the surface is occupied by a squareish surface which is divided by a vertical and a transverse line into two parts, upper and lower.

Joint Movements.—The knee being mainly a hinge joint, its usual motions are flexion and extension, but in addition there is rotation of the leg when the joint is semiflexed.

In Flexion the tibia and its fibro-cartilages pass backwards on the femur. This movement is checked by the meeting of the calf with the back of the thigh, and also by the quadriceps extensor. In the first part of this motion the tibia moves down and in, on the oblique curvature of the internal condyle, causing internal rotation of the leg. In the posterior two-thirds of this movement the tibia moves directly backwards over the condyles. The ligamentum patellæ is rendered tense, and at the end of flexion both crucials are put on the stretch. The extra-articular ligaments are all relaxed in flexion.

In Extension the tibia passes forwards until it is in a line with the femur, hyper-extension being checked by the posterior ligament, the tendons of the hamstring muscles, and the anterior crucial. During the anterior third of extension the tibia passes up and out over the oblique curvature of the internal condyle, and is also rotated out. In the posterior two-thirds of this motion the tibia passes directly forwards over the condyles. The extra-articular ligaments, with the exception of the anterior, are stretched, and both crucials, especially the anterior, prohibit extreme extension.

In rotation, it is necessary that the knee be semiflexed, so that the extra-articular ligaments and the anterior crucial may relax. The foot must also not be fixed. In this movement the big toe is turned either in or out, and the tibia with its fibro-cartilages rotates around an axis vertical to the bone.

In *Internal Rotation* the inner articular surface of the tibia passes back, touching the inner femoral condyle, and the external articular surface passes forwards, being slightly separated from the external condyle. The anterior crucial is by degrees rendered tense, and finally checks the motion. The lateral ligaments are relaxed.

In *External Rotation* the opposite condition to that just described takes place, the great toe being pointed outwards. The crucials are unaffected, but the internal lateral ligament is rendered tense and tends to check the motion.

Movements of the Patella.—In the passage from flexion to extension the patella passes obliquely from the external to the internal side, and touches different parts of the femoral condyles in succession. In passing from flexion to extension the superior pair of facets, and subsequently the inferior pair on the square surface of the patella, touch the femur in succession. The trochlear, or pulley-like surface of the femur near the joint is completely extended. The patella is drawn up by the extensors, and its two inferior facets come in contact with the upper and inner parts of the femoral surface. It is then very prominent, and the ligamentum patellæ, and patellar apex, are directed towards the tibia downwards and outwards. Only the lower transverse facet of the patella is in contact with the upper edge and trochlear surface of the patella in this movement.

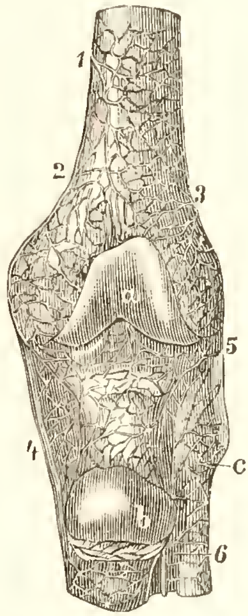
In semiflexion only the middle facets of the patella are in contact with the femur. In complete flexion the patella lies on the external side below the femur, being fixed in this position and scarcely perceptible. It then touches the semilunar surface of the inner condyle by its vertical facet, and the inferior part of the external condyle by the superior and external facet on its square surface.

It will thus be seen that each part of the femoral articular surface

appertains either to one or other of the three joint surfaces peculiar to the knee, and that each part is quite distinct from the others. This joint may be considered as comprised of three articulations conjoined, viz. one between each femoral condyle and tibia, and one between the femur and patella. In most mammals these surfaces are either completely or nearly completely separated, and in man the ligamentum mucosum is the remnant of the original separation of the synovial membranes of the outer and inner joints, the crucial ligaments being regarded as the outer and inner lateral ligaments of these respective joints.

The joint between each condyle and the corresponding tibial surface is very like, though not exactly, a hinge joint, and the motions of extension and flexion are a combination of rotation, gliding, and rolling.

Relations.—In *front* the knee joint is subcutaneous, being covered only by the skin, subcutaneous tissue, and expansions of the fascia lata. The pre-patellar bursa is found in the tissue between the skin and patella, and there are two bursæ at the insertion of the ligamentum patellæ: one



1 and 2. Branches of int. sup^r. artic.
3. Branches of ext. sup^r. artic.
4. " int. inf^r. "
5. " ext. " "
6. Ant^r. tibial recurrent.
a. Intercondyloid groove.
b. Post^r. surface of patella.
c. Head of fibula.

FIG. 401.—DEEP ANASTOMOSES AROUND LEFT KNEE. ANTERIOR VIEW.

is subcutaneous and the other between the tendon and the tibia. *Behind* are the popliteus and the popliteal vessels and nerves in the mid-line, and the two heads of the gastrocnemius and the plantaris on either side. *Inside* are the tendons of the sartorius, gracilis, semitendinosus, and semimembranosus, and the bursæ in connection with them. *Outside* are the tendon of biceps, the external popliteal nerve, and the expansion of the tensor fasciæ femoris.

Blood-vessels.—The arteries are the articular from the popliteal and articular branches of the anastomotica magna and recurrent tibial, and form a rich network around the joint. The venæ comites join the popliteal and femoral veins, and the lymphatics of the joint communicate with those of the cancellous tissue of the bones forming the articulation, and join the popliteal glands.

The *Nerves* come from the anterior crural, obturator, and external and

internal popliteal. The internal saphenous not infrequently sends branches through the capsule to its synovial lining. Filaments from the branch of the vastus externus and of the external popliteal enter the joint with the superior external articular artery in *front*, as also do twigs from the internal saphenous. *Behind*, both popliteals supply the joint, and one twig accompanies the azygos articular artery. *Inside*, a branch from the internal popliteal accompanies the inferior internal articular, and outside a branch from the anterior tibial runs with the anterior tibial recurrent artery.

Muscles which produce the movements.—Flexion is affected by the

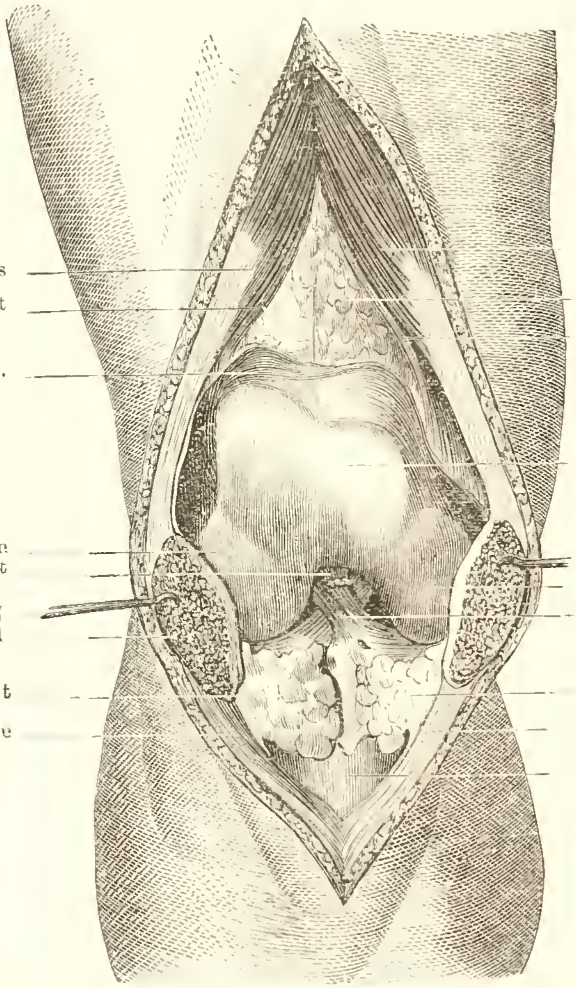


FIG. 405.—RIGHT KNEE OPENED FROM THE MID-FRONT.

The pre-patellar bursa is partly shown in section on the left of the figure, but the bursa between the skin and lig. patellæ is not.

biceps, semitendinosus, semimembranosus, gracilis, sartorius, gastrocnemius, and poplitens.

Extension by the quadriceps and tensor fasciæ latæ.

Internal rotation by the sartorius, semitendinosus, gracilis, poplitens, and slightly by the tensor fasciæ latæ.

External rotation by the biceps.

The *bursæ* in the neighbourhood of the joint are, in *front*, the prepatellar and one superficial to, and another beneath, the ligamentum

patellæ at its insertion; *behind* there is one beneath the inner and another under the outer head of the gastrocnemius, which sometimes communicates with the joint; *outside*, there is one beneath the tendon of the popliteus, which is almost always an extension of the synovial membrane, and occasionally there is another above the popliteus tendon, between it and the external lateral ligament. *Inside* there is either a separate one under the tendon of the semimembranosus or an expansion from the inner gastrocnemius bursa. This is in contact with the posterior ligament, and often communicates with the joint. Another bursa exists

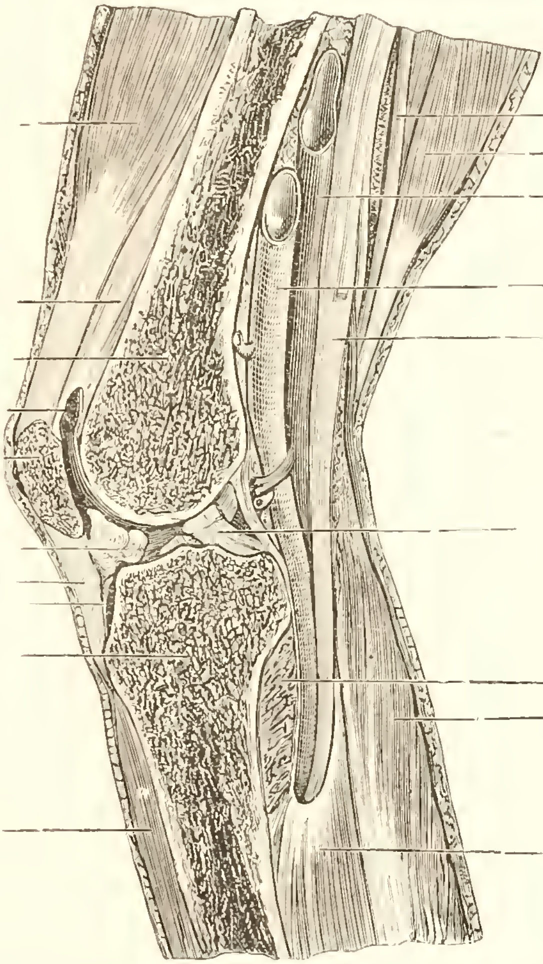


FIG. 406.—VERTICAL LONGITUDINAL SECTION OF LEFT KNEE.

Inner part of section which is slightly external to mid-line. The vessels are shown passing under the fibrous arch of the soleus.

between the tendon of the semimembranosus and the head of the tibia, and frequently one between the tendons of the sartorius, gracilis, and semitendinosus. It is of great practical importance to remember which of these bursæ are most commonly in communication with the joint, as effusions into them are not of infrequent occurrence. Two *sesamoid* bones, or fibro-cartilages, may be found (and occasionally three) in relation with the joint; one is in the outer head of the gastrocnemius, and the other in the tendon of the popliteus. A third sometimes exists in the inner head of the gastrocnemius. They very rarely ossify.

FRONT OF THE LEG AND DORSUM OF THE FOOT.

Directions.—Place blocks beneath the knee to raise the limb to a convenient position, and extend the foot so as to stretch the extensors.

Dissection.—Make an incision along the middle of the leg from the knee to the toes. Cuts transverse to this should be made through the skin at the ankle and at the webs of the toes; the skin should be reflected from the leg and toes.

The *Cutaneous vessels and nerves* of these parts must be sought in the following positions. Ascending along the inner side of the foot and passing in front of the inner malleolus, then along the inside of the leg, is the

FIG. 107.—DIAGRAM OF INCISIONS FOR DISSECTING THE LOWER LIMB.

internal saphenous vein. It begins in a minute plexus on the inner side and dorsum of the foot, and receives branches from the sole and inner side of the foot, and cutaneous veins from the leg. It also communicates with the internal plantar in the foot, and with the posterior and anterior tibial veins, and at the knee with the articular veins. Its valves are more numerous in the thigh than in the leg.

The *external saphenous vein* begins in common with the internal from the venous arch on the dorsum of the foot, and by veins from the dorsum and outer side of the foot. It ascends behind the external malleolus and

along the outer border of the tendo-Achillis, being accompanied by the external saphenous nerve. It then crosses the tendo-Achillis to the middle of the posterior aspect of the leg, where it has already been seen.

The *Venous Arch* on the dorsum of the foot receives digital branches from the toes, gives origin to the two saphenous veins, and at its concavity which is towards the ankle is joined by several small veins over the instep

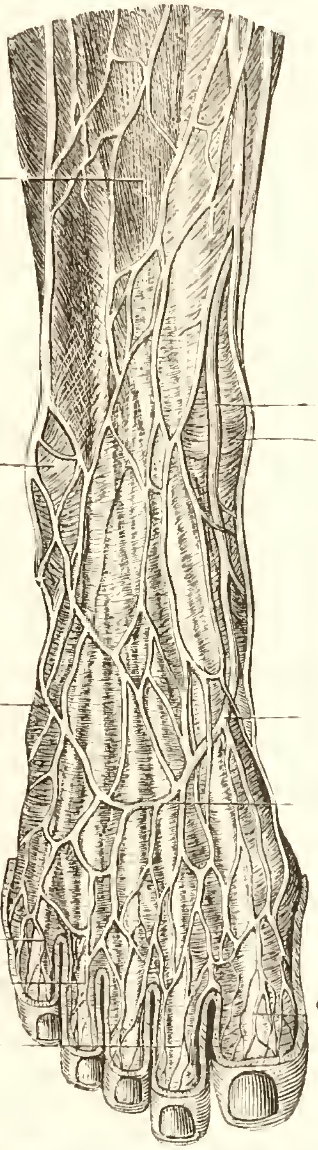


FIG. 408.—VEINS ON DORSUM OF RIGHT FOOT.

Cutaneous Nerves.—These come mainly from the internal and external popliteal nerves. Some branches from the internal saphenous ramify on the sides of the leg. The internal saphenous may be traced along the inner side of the leg as far as the phalangeal joint, giving twigs backwards and forwards. On the outer side of the leg in its upper half are cutaneous branches of the external popliteal which pierce the deep fascia on the front of the leg. At its lower third is the musculo-cutaneous branch of the external popliteal, which divides into an outer and inner branch and should be traced to the toes. On the outer side of the foot the external saphe-

nous nerve must be defined and traced to the outer side of the little toe; and between the great and second toes will be found the termination of the anterior tibial supplying the skin and the adjoining sides of the great toe and toe next it. The nerves and vessels to the toes should be traced

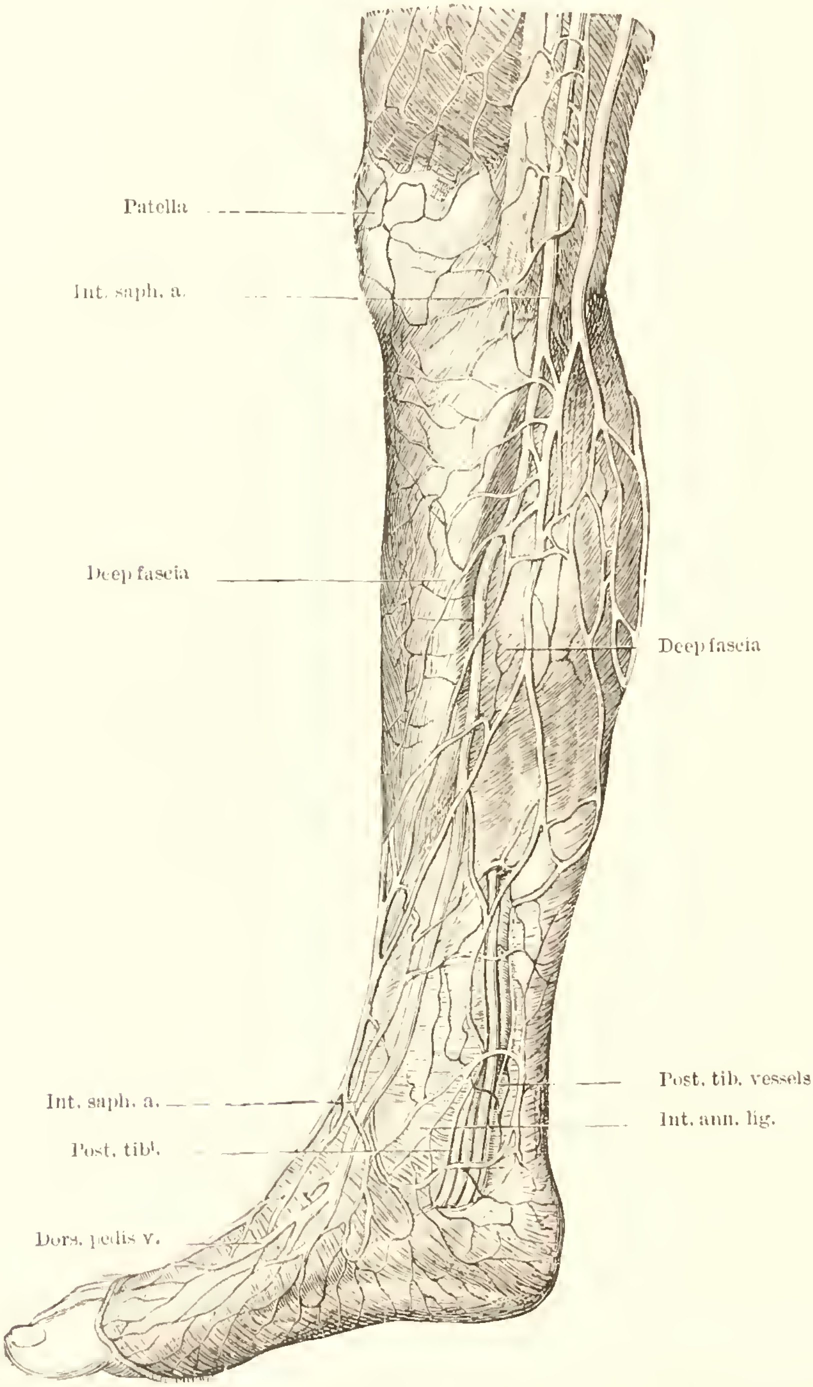


FIG. 109.—RIGHT INTERNAL SAPHENA VEIN, LOWER PART, SHOWING ANASTOMOSES BETWEEN IT AND POSTERIOR TIBIAL VEIN.

out, and then the superficial fascia and fat should be removed so that the deep fascia may be seen. The cutaneous arteries of this region come mainly from the anterior tibial and its branches and from the peroneal.

The student must first study the origin and distribution of the cutaneous nerves, and then the attachments of the deep fascia.

The *Internal Saphenous nerve* is a continuation of the nerve which has already been dissected in the thigh, and accompanies the vein of the same name along the inner side of the leg, passing behind the inner border of the tibia, and at the lower third of the leg divides into two branches; one passes on along the inner tibial margin ending at the inner ankle, the other passes in front of the ankle with the vein and supplies the skin along the inner side of the foot as far as the metatarso-phalangeal joint. Some twigs from this branch pierce the deep fascia to supply some of the tarsal joints.

The *External Saphenous nerve*, from the internal popliteal, will be seen behind the outer malleolus in company with the vein, and passes

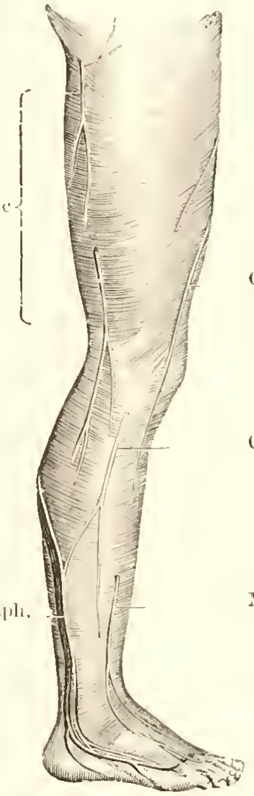


FIG. 110.—CUTANEOUS NERVES OF OUTER SIDE OF RIGHT LEG.

along the outer side of the foot and little toe which it supplies. It gives offsets on the dorsum and to the sole, the latter being the larger. Sometimes it supplies both sides of the little toe and the outer part of the next.

The *Cutaneous Branches* of the *External Popliteal* are two or three in number, and are found on the outer side of the leg as far as its middle or lower third.

The *Musculo-cutaneous nerve* pierces the deep fascia on the front and outer side of the leg at its lower third. It is usually accompanied by a cutaneous artery, and divides shortly after having perforated the fascia into an inner and outer branch. The *internal* branch passes in front of the ankle and along the dorsum of the foot to supply the inner side of the

great toe and the contiguous sides of the second and third toes. It also supplies the skin of the inner ankle and inner side of the foot, joining the internal saphenous nerve, and also the anterior tibial between the big and

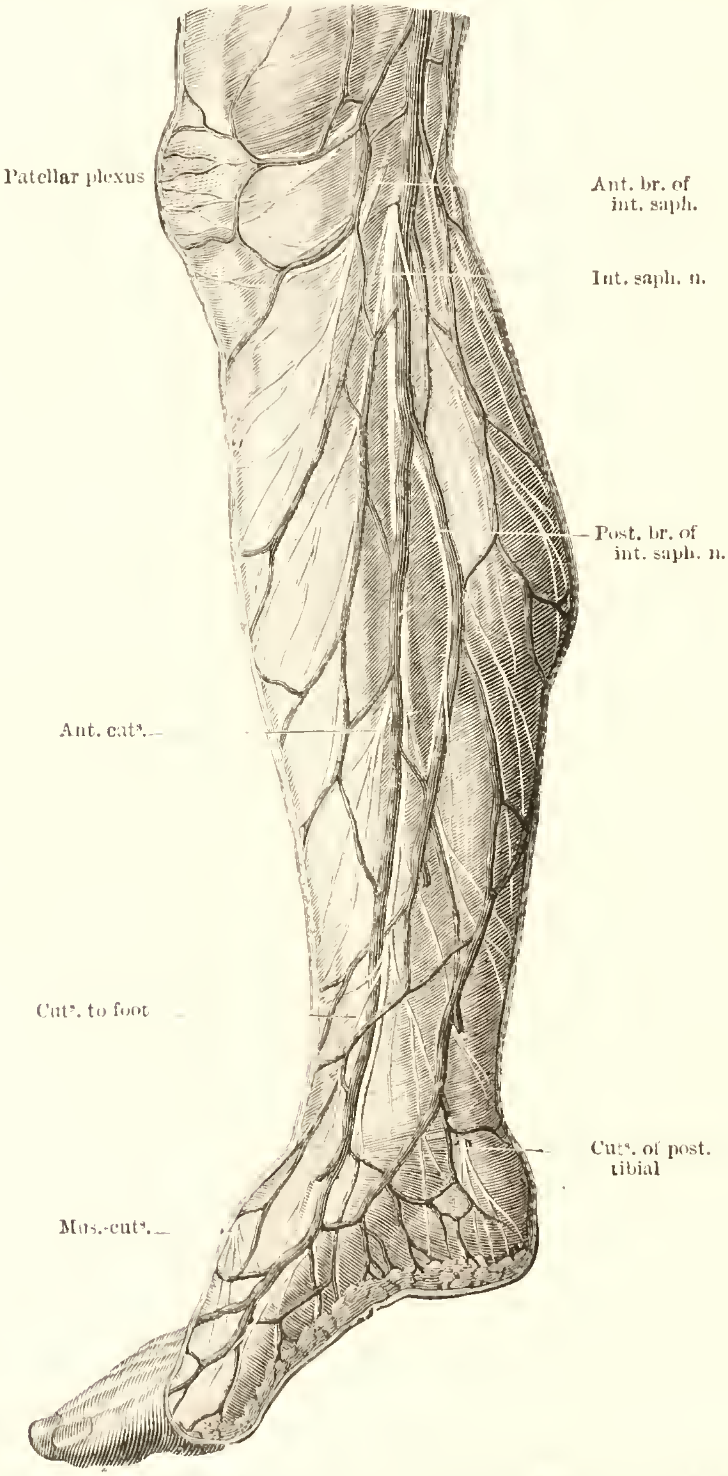


FIG. 411.—CUTANEOUS NERVES AND VEINS OF THE RIGHT LEG. INTERNAL VIEW.

second toes. The *external* branch is the larger, and passes on the outer side of the dorsum of the foot, dividing into three branches which lie over the three outer interosseous spaces, and at the webs of the toes bifurcate to

supply the adjoining sides of the third, fourth, and fifth toes. It also supplies the skin of the outer ankle and outer side of the foot, and joins the external saphenous nerve. The arrangement of the branches of this nerve is subject to individual variations; they usually supply all the toes on the dorsal aspect of the foot excepting the outer side of the little toe, which

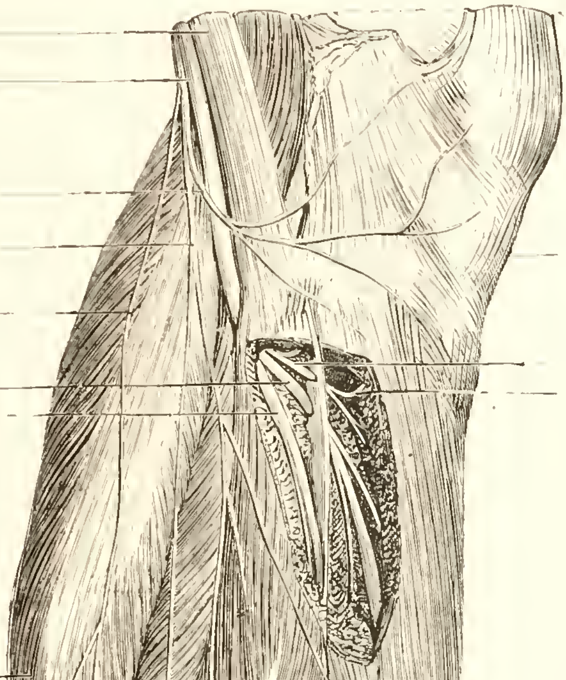


FIG. 412.—TERMINAL BRANCHES OF THE RIGHT EXTERNAL POPLITEAL NERVE.

A window has been made in the tibialis anticus.

is supplied by the short saphenous, and the adjoining sides of the great and second toes, which are supplied by the anterior tibial.

The *Anterior Tibial Nerve.* — Only that part of the nerve which becomes cutaneous at the fore part of the first interosseous space is now seen. It supplies the contiguous sides of the great toe and the next, and

is joined by the musculo-cutaneous, which occasionally assists in supplying the same digits.

The *deep fascia* of the front of the leg completely covers the soft parts in this region. At its upper and fore part it is strong and thick, and is continuous with the fascia lata above, and receives expansions from the hamstring tendons. It is attached to the outer margins of the tibia and fibula blending with their periosteum, and below it is continuous with the anterior annular ligament. From its deep surface it gives origin to the muscles in front of the leg, and also furnishes intermuscular septa. On

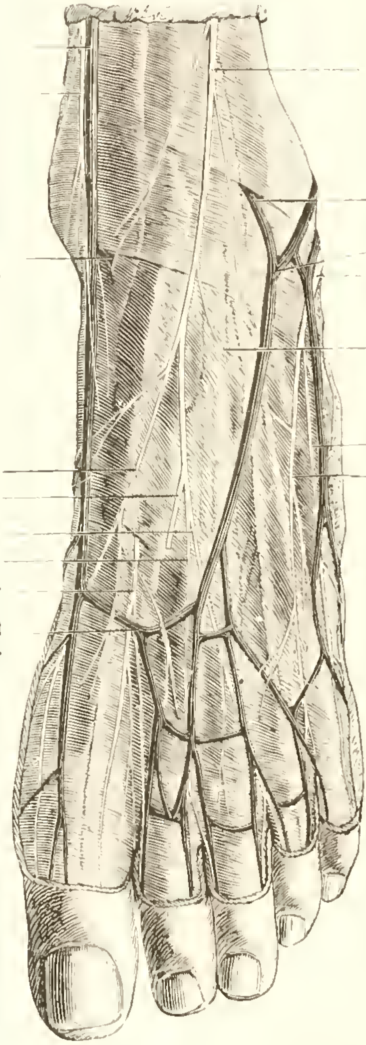


FIG. 113.—VEINS AND NERVES OF DORSUM ON LEFT FOOT.

the outer side of the leg it gives off two strong intermuscular septa which include the peronei and separate them from the muscles on the anterior and posterior tibial regions, and a broad transverse septum—the deep fascia of the front of the leg—is continuous with its intermuscular septa, and separates the superficial muscles of the posterior tibio-fibular regions from the deep.

Below the end of the fibula it is continuous with and helps to form the external annular ligament, and above and below the ankle joint it is re-

inforced by oblique fibres, and forms the two parts of the anterior annular ligament. At the upper part this fascia is also attached to the heads of the tibia and fibula.

The fascia on the dorsal aspect of the foot is a very thin membranous layer and is lost at the heads of the metatarsal bones, blending on the outer and inner sides of the foot with the lateral pieces of the plantar fascia. It is continuous with the lower margin of the anterior ligament, and forms the sheaths for the tendons placed on the dorsum of the foot. This should now be removed to expose the muscles and tendons in this region. Another thin layer of fascia will be found over the extensor brevis digitorum, and beneath it and above the interossei is a third layer of fascia which will subsequently be seen.

Dissection.—Remove the deep fascia, leaving the anterior annular and external annular ligaments. The fascia will be best removed from the muscles by dissecting from below upwards. The peronei muscles on the outer side should also have the fascia removed from them. In doing this the strong intermuscular septa must be noted. Trace up the anterior tibial vessels and nerve and the musculo-cutaneous nerve from the dorsum of the foot to their origin; and on the dorsum of the foot clean the dorsal vessels and nerve and trace the tendons of the long and short extensors to the ends of the toes.

The *Anterior Annular Ligament* is composed of two portions, upper and lower; and binds down the extensor tendons to the front of the tibia and fibula, and to the tarsus. The *upper* or *oblique* part is above the level of the ankle joint, and is attached internally to the tibia and inner malleolus, and externally to the outer margin of the fibula. It is continuous above with the fascia of the leg, and contains, usually, only one sheath and synovial membrane, which is for the tibialis anticus; but sometimes there are two, the outer one being for the tendons of the extensor longus digitorum and peroneus tertius. The tendons of the extensor proprius pollicis, and the anterior tibial vessels and nerve, pass beneath it without any distinct sheath.

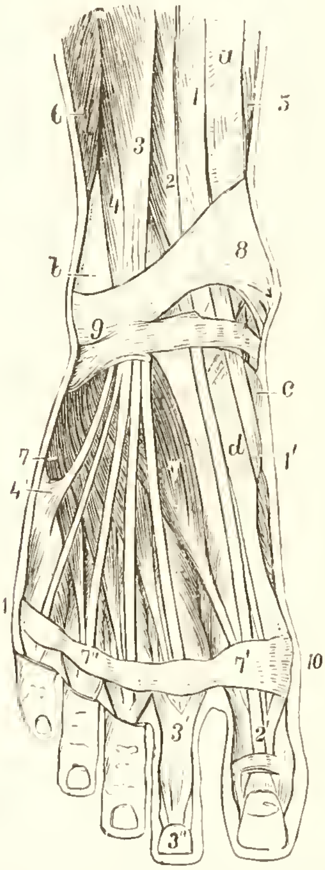
The *lower horizontal* part is placed opposite the bend of the ankle and in front of the upper tarsal bones. It has the appearance of a capital letter Y, placed thus, being single in its outer half, and commonly divided into two limbs internally. The outer part is composed of a strong loop of fibres arising from the upper surface and fore part of the os calcis, deeply in the hollow between that band and the astragalus, and in front of the interosseous ligament. Internally it is thin and widens, and the arrangement of the two bands is somewhat irregular. The most constant and stronger band is superficial to the extensor pollicis, and on the deep surface of the tibialis anticus, only a few fibres being superficial to the latter. This band is attached to the inner malleolus and inner part of the plantar fascia. The lower band crosses the tibialis anticus and extensor pollicis, and is inserted into the lower side of the foot in front of the ankle. In this part of the ligament there are three sheaths, the innermost for the tibialis anticus, the middle for the extensor pollicis, and the outer for the extensor longus digitorum and peroneus tertius. The anterior tibial vessels and nerve lie beneath it. Each tendinous sheath has a separate synovial membrane.

The *External Annular Ligament* is triangular and attached by its apex

to the tip of the external malleolus, and below, to the outer surface of the calcaneum, being connected to the sheaths of the peronei muscles. The peroneus longus and brevis are contained beneath it in one compartment, and are surrounded by one common synovial membrane which sends offsets down along the sheaths of these muscles nearly to their insertion.

The *muscles* on the front of the leg are placed between the tibia and fibula, and are four in number, viz. the tibialis anticus, extensor proprius pollicis, extensor longus digitorum and peroneus tertius; and on the dorsum of the foot there is but one muscle, the extensor brevis digitorum.

The **Tibialis anticus** is placed next the outer side of the tibia, is thick and fleshy above and tendinous below, and *arises* from the external tubero-



a. Tibia.
b. Fibula, ext. malleolus.
c. Scaphoid.
d. Int. cuneiform.
1 1. Tib. ant.
2 2. Ext. prop. hall.
3. Ext. dig. com.
3 3'. Its insertions.
4. Peron. tert.
4. Its insertion.
5. Soleus.
6. Peron. brev.
7. Ext. brevis dig., its innermost tendon joining the outer side of flex. prop. hall.
7' 7'. Tendons of ext. brev. joining those of longus.
8 9. The two pieces of ant. ann. lig.
10 11. Transverse piece of dorsal pedal fascia at bases of toes, keeping tendons in place.

FIG. 414.—SUPERFICIAL MUSCLES AND TENDONS ON DORSUM OF RIGHT FOOT. ONE-THIRD.

sity and upper two-thirds of the tibia, from a part of the adjoining interosseous ligament, from the intermuscular septum between it and the extensor longus digitorum, and from the deep fascia of the leg. Its fibres pass vertically down and end in a tendon on its anterior surface just below the middle of the leg. It then passes through the *innermost* compartment of the anterior annular ligament, and is *inserted* into the inner and lower part of the internal cuneiform bone and base of the metatarsal bone of the great toe. It divides slightly into two slips as it descends.

Relations.—By its *anterior* surface with the deep fascia and the annular ligament; by its *posterior* with the interosseous membrane, the end of the tibia, the anterior ligament of the ankle joint, and the inner

side of the tarsus. It overlaps the anterior tibial vessels and nerves in the *upper* part of the leg. Its *inner* border is in contact with the tibia, and its *outer* with the extensor longus digitorum above, and below with the extensor pollicis and anterior tibial vessels and nerve.

Varieties.—Wood has described a small muscle, the *tibio-fascialis anticus*, which passes from the lower third of the anterior edge of the tibia over the tibialis anticus, to be inserted into the annular ligament and deep tibial fascia. It may exist as a tendinous slip from the tibialis anticus. in cases of talipes the tendon of the tibialis anticus is often found divided

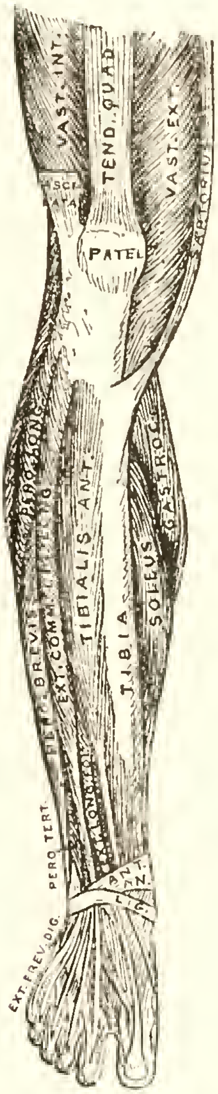


FIG. 415.—MUSCLES OF THE FRONT OF THE RIGHT LEG.

into two, one part being inserted in the usual way, the other going to the astragalus or first metatarsal bone. Sometimes the whole tendon has been inserted into the inner piece of the plantar fascia.

Actions.—If the foot be free this muscle flexes the ankle, and in consequence of the oblique direction of its tendon it will raise the inner border of the foot and turn the big toe inwards. In the erect position, the foot being fixed, it will assist the other extensors in maintaining the leg bones in the perpendicular position, and will strengthen the ankle.

In this position it, and the tibialis posticus, can raise the inner border of the foot and support it on its outer edge.

Nerve.—The anterior tibial, and at its upper part by the recurrent branches of the external popliteal.

The **Extensor Proprius Pollicis,** or *Extensor Hallucis,* is at its origin situated deeply between the tibialis anticus and the extensor longus digitorum. It *arises* from the middle three-fifths of the anterior narrow portion of the inner surface of the fibula, internal to the origin of the

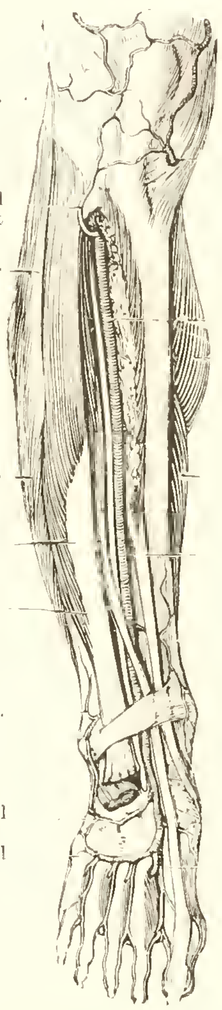


FIG. 416. MUSCLES OF FRONT OF RIGHT LEG AND ANTERIOR TIBIAL AND DORSALIS PEDIS ARTERIES.

The ext. brev. dig., tib. ant., ext. com. dig., and ant. tibial nerve have been cut; the first and last below ant. ann. lig.

extensor longus digitorum. It also arises from the contiguous part of the interosseous ligament to a similar extent. Its fibres pass obliquely down and in to a tendon occupying the anterior and inner border of the muscle. This tendon becomes superficial at the ankle and passes through a distinct sheath in the lower part of the annular ligament. It crosses the anterior tibial vessels near the bend of the ankle, and passing over the inner part of the tarsus is *inserted* into the base of the terminal phalanx of the great

toe on its dorsal aspect. The tendon gives off a strongish expansion on each side over the metatarso-phalangeal joint and to the first phalanx.

Relations.—*Anteriorly* with the deep fascia and the anterior annular

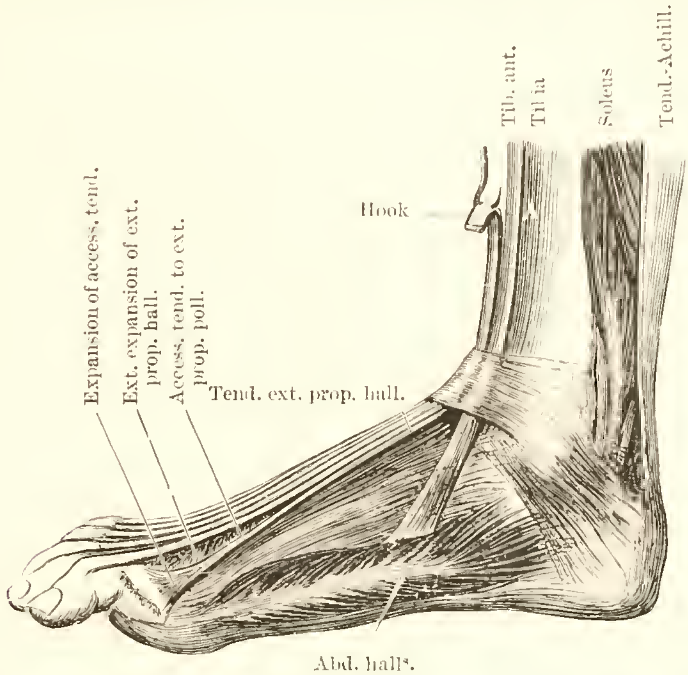


FIG. 417.—INNER VIEW OF MUSCLES AND TENDONS OF RIGHT FOOT AND TOES.

The ext. expansion is seen from its inner side after removal of the internal expansion so as to show that beneath the fibrous expansion of the ext. prop. hall. there are no strong and short fibres like those in connection with the ext. long. dig.

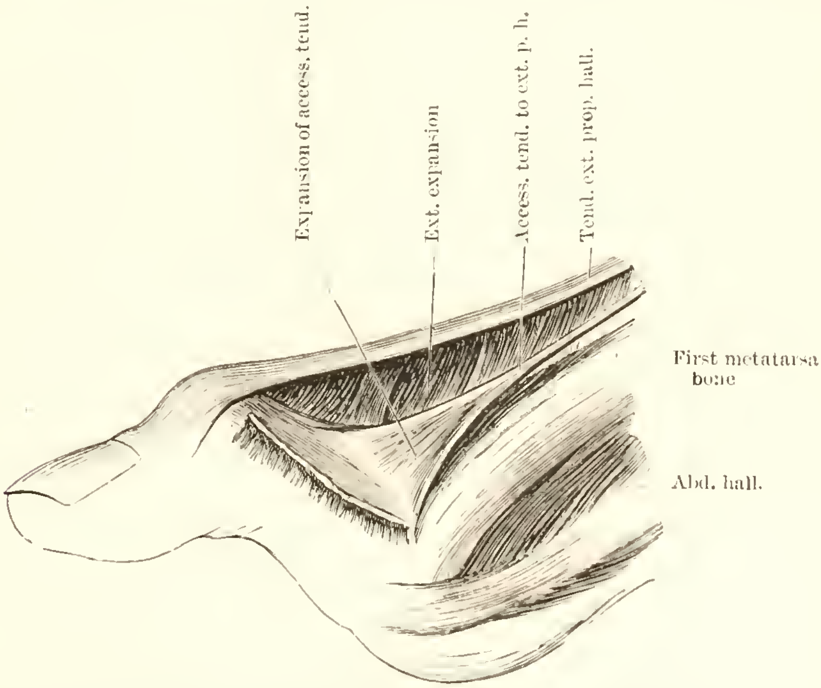


FIG. 418.—THE GREAT TOE OF THE PREVIOUS FIGURE, ENLARGED.

ligament; *posteriorly* with the interosseous membrane; the tibia, fibula, ankle joint, and innermost belly and tendon of the extensor brevis digitorum; *externally* with the extensor longus digitorum above, the anterior

tibial artery and nerve and dorsalis pedis below; *internally* with the tibialis anticus, and anterior tibial vessels and nerves above. Beneath the anterior annular ligament it crosses the anterior tibial vessels and nerve.

Varieties.—This muscle, or the tibialis anticus or extensor longus digi-

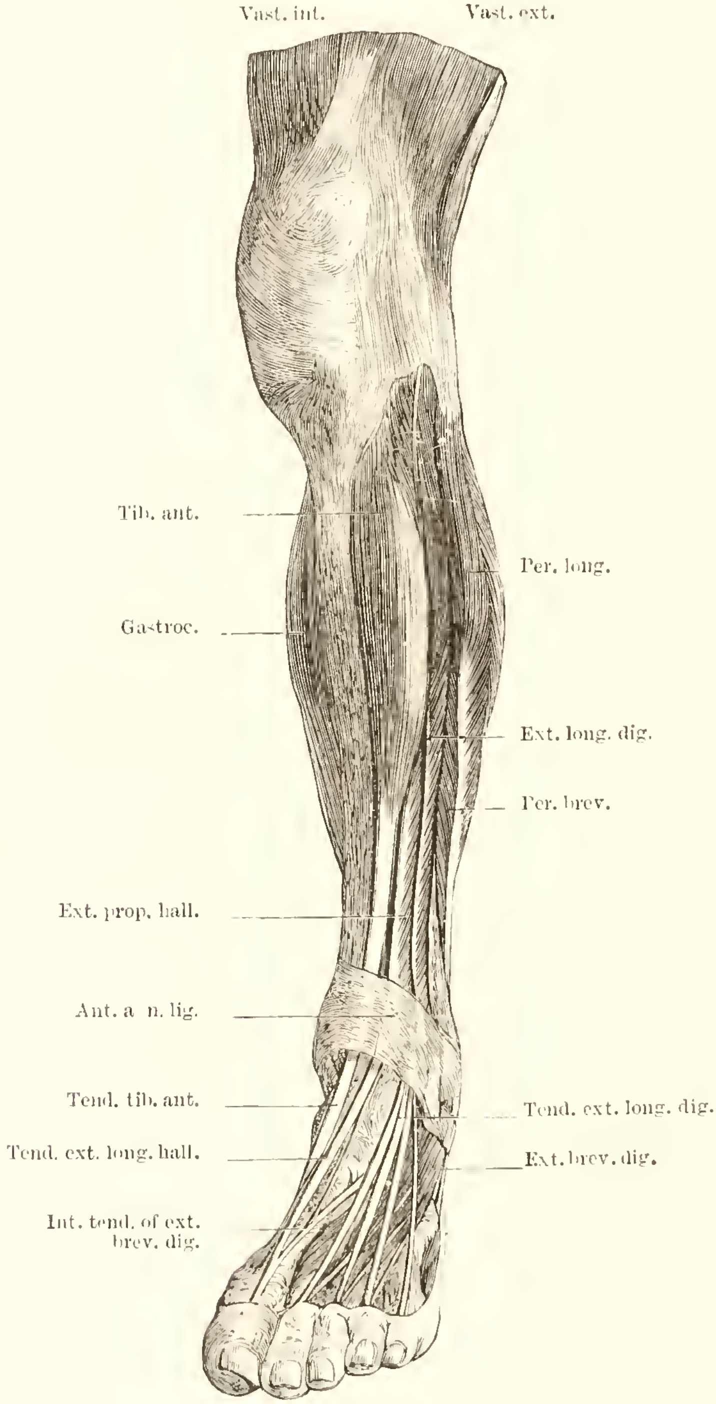


Fig. 419.—Anterior muscles of left leg.

torum, sometimes gives off a small slip which has been named the *extensor ossis metatarsi pollicis*; or this may be a distinct muscular slip arising close to the extensor proprius and passing through the same compartment with it. Another occasional muscle, the *extensor primi internodii*

pollicis, is almost always given off from the extensor proprius, though it has been found separate. Wood found it in half the subjects examined. When present it is usually inserted into the first phalanx of the great toe, or into the first metatarsal, or into both.

Actions.—It extends the phalanges of the great toe, and then flexes the ankle. If the foot be fixed, it can draw the tibia forwards.

Nerve.—The anterior tibial.

The **Extensor Longus Digitorum** is a long flattened penniform muscle, and is fleshy above and tendinous below. It *arises* from the external tuberosity of the tibia, from the front of the head and upper three-fourths of the anterior narrow part of the inner surface of the fibula, from a small part of the interosseous membrane, and from the deep fascia and inter-muscular septa. The muscular fibres pass obliquely down and in, to three

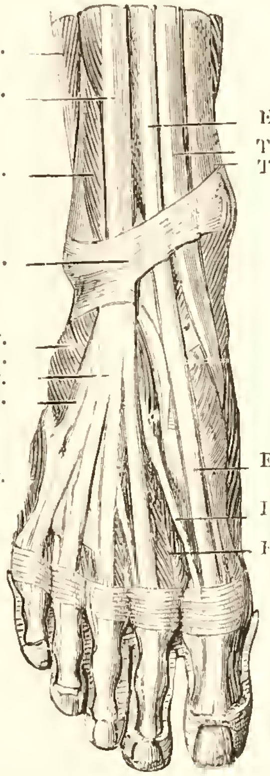


FIG. 420.—MUSCLES AND TENDONS IN FRONT OF RIGHT LEG AND ON DORSUM OF FOOT.

The transverse piece of the dorsal fascia keeping the tendons in place is shown.

tendons which, with the peroneus tertius, pass in a separate compartment through the annular ligament, the innermost tendon dividing into two. It then crosses the dorsum of the foot, and is inserted into the dorsal aspects of the second and third phalanges of the four outer toes. These tendons have the same arrangement on the toes as the extensors of the fingers. The three inner tendons are joined on the first phalanx at their *outer* sides by a tendon from the extensor brevis digitorum, and also by an aponeurotic expansion from the interossei and lumbricales which covers the dorsum of the first phalanx. At the anterior part of this phalanx, this aponeurosis divides into three slips, a middle and two lateral. The middle one is *inserted* into the dorsal aspect of the base of the second phalanx, and the two lateral unite on the dorsal surface of the second phalanx and

pass on to be *inserted* into the base of the third phalanx on its dorsal aspect.

Relations.—*Anteriorly* with the deep fascia and annular ligament, *posteriorly* with the external tuberosity of the tibia, anterior surfaces of the fibula, interosseous membrane, ankle joint, and extensor brevis digitorum. *Internally* with the tibialis anticus, extensor proprius pollicis, and anterior tibial vessels and nerve. *Externally* with the peroneus

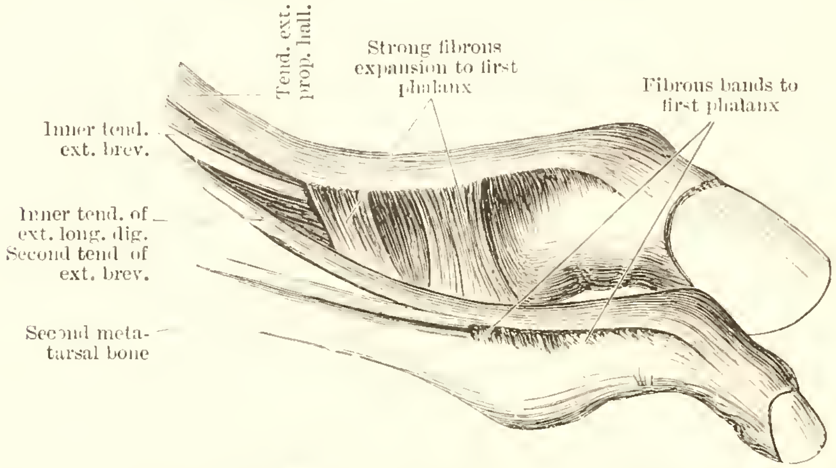


FIG. 421.—TO SHOW THE MODE OF INSERTION OF THE EXTENSORS INTO THE TOES.

longus and brevis. The anterior tibial nerve passes obliquely under its upper part.

Varieties.—The tendons of this muscle vary considerably in their position, number, and method of insertion. External slips are commonly given off from one or more of the tendons to the corresponding metatarsal bones or to the extensor brevis or one of the interossei. The tendons to

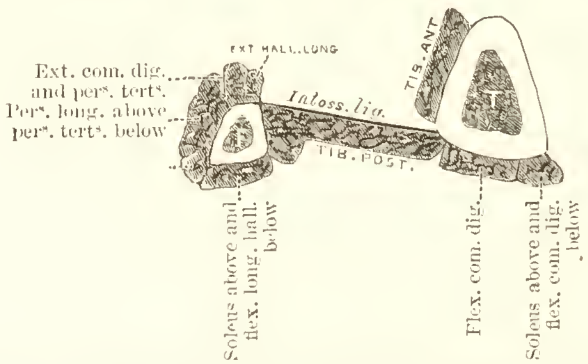


FIG. 422.—TRANSVERSE SECTION THROUGH RIGHT LEG TO SHOW THE RELATIVE POSITIONS OF THE BONES AND MUSCLES.

the second and fifth toes may also be found doubled, and in one instance there was a special belly for the fourth toe which gave off four tendons passing to the fourth metatarsal and three phalanges. It may send a tendinous expansion to the extensor pollicis.

Actions.—It extends the joints of the four lesser toes from tip to root, and continuing its action, flexes the ankle joint. Acting from *below*, it will steady the tibia and fibula on the astragalus, and if the tibia be in-

clined back it will be drawn forwards by this and the other muscles on the front of the leg.

Nerve.—The anterior tibial.

The **Peroneus Tertius** is seldom separate from the extensor longus digitorum, below which it is placed. It might be described as the fifth tendon of the extensor longus. It arises from the lower fourth of the narrow portion of the internal surface of the fibula on its outer side, from the lower part of the interosseous membrane, and from the intermuscular septum between it and the peroneus brevis. Its tendon passes through the same compartment of the annular ligament as that of the extensor longus, and is inserted into the dorsal surface of the base of the metatarsal bone of the little toe on its inner side.

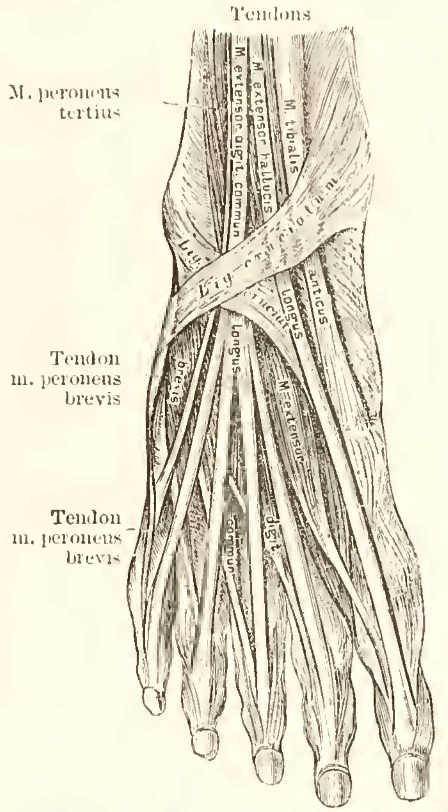


FIG. 423.—TENDONS AND MUSCLES ON DORSUM OF RIGHT FOOT.

Relations.—On the *outer* side is the long extensor, with which it is joined at its origin, and with which it passes through the same compartment of the annular ligament.

Varieties.—It may be absent or it may be as large as the long extensor. Occasionally it is inserted on the fourth metatarsal bone, or it may send a slip to the extensor tendon for the fifth or fourth toe, or to the fourth dorsal interosseous muscle.

Action.—It flexes the ankle, and helps to draw forwards the tibia when the leg is advanced in walking,

Nerve.—The anterior tibial.

Synovial sheaths of the tendons.—There are usually three of these for the extensor tendons; one for the tibialis anticus, one for the extensor proprius hallucis, and another for the extensor communis digitorum and

peroneus tertius. The first extends commonly from about two inches above the annular ligament to about half an inch below it; the second extends from about half an inch above the ligament to about two inches below it; and the third, which is the most extensive, extends from about the same distance above the ligament obliquely down and in to near the roots of the toes. One or more of these sheaths sometimes become distended with fluid and form what are termed *ganglions*.

The **Anterior Tibial Artery** corresponds to a line drawn from the inner side of the head of the fibula to midway between the malleoli. It is given off from the popliteal at the lower border of the popliteus muscle, and passes forwards through the oval aperture at the upper part of the interosseous membrane between the two heads of the tibialis posticus, and

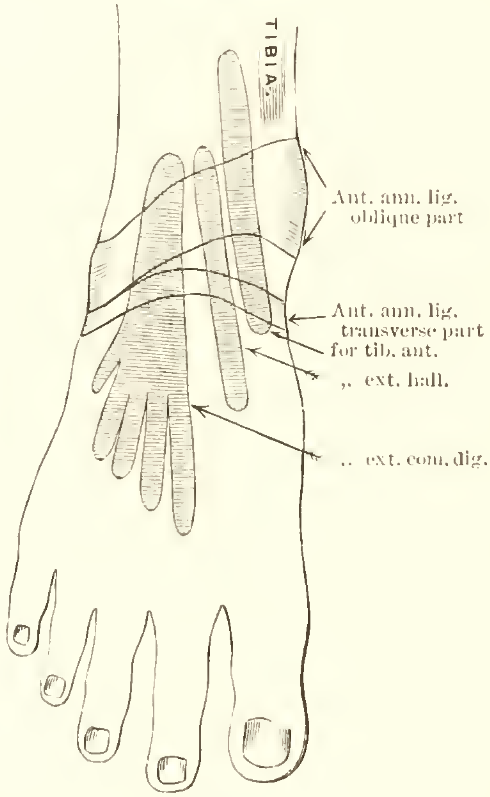


FIG. 424.—DIAGRAM OF THE SYNOVIAL SHEATHS OF THE EXTENSORS OF RIGHT FOOT.

resting on the interosseous membrane, runs down to the front of the ankle joint where it becomes more superficial, and at the lower border of the anterior annular ligament it is called *the dorsalis pedis artery*.

Relations.—In its upper two-thirds it is deeply placed, but becomes superficial at the lower third. It rests on the interosseous membrane at its upper two-thirds, and is connected to it by fibrous arches passing over the vessel. In the lower third it rests upon the front of the tibia and the anterior ligament of the ankle joint. In its upper third it is between the tibialis anticus and extensor longus digitorum; in the middle third between the tibialis anticus and extensor pollicis; and in the lower third the tendon of the extensor pollicis crosses it, and it lies between the innermost tendon of the extensor longus digitorum and the tendon of the

extensor pollicis. In front of it are the skin, superficial and deep fascia, and annular ligament; and at its upper two-thirds it is covered by the tibialis anticus, extensor longus digitorum and extensor pollicis. Two venæ comites accompany it, and are closely joined on its upper part by

FIG. 425.—ARTERIES IN FRONT OF RIGHT LEG.

The tib. ant. and ext. hall. are cut.

transverse branches, and the anterior tibial nerve is first to its outer side, but about the middle of the leg is in front of it, and at the lower part of the vessel the nerve is usually found on the outer side.

RELATIONS OF THE ANTERIOR TIBIAL ARTERY.

In front.—Skin, sup. and deep fasciæ and anterior annular ligament tibialis anticus in upper part of leg, extensor longus digitorum, extensor proprius pollicis, and anterior tibial nerve.

Inside.—Tibialis anticus, and the extensor proprius pollicis crosses it at its lower part.

Anterior Tibial Artery

Outside.—The anterior tibial nerve, extensor longus digitorum, and extensor proprius pollicis.

Behind.—The interosseous membrane, tibia, and anterior ligament of the ankle joint.

Branches.—These are the recurrent tibial, cutaneous, muscular, internal and external malleolar, and articular to the ankle.

The *Recurrent Tibial* is given off directly the vessel passes through the interosseous membrane. It ascends in the tibialis anticus to the front and sides of the knee joint, anastomosing with the inferior articular branches of the popliteal.

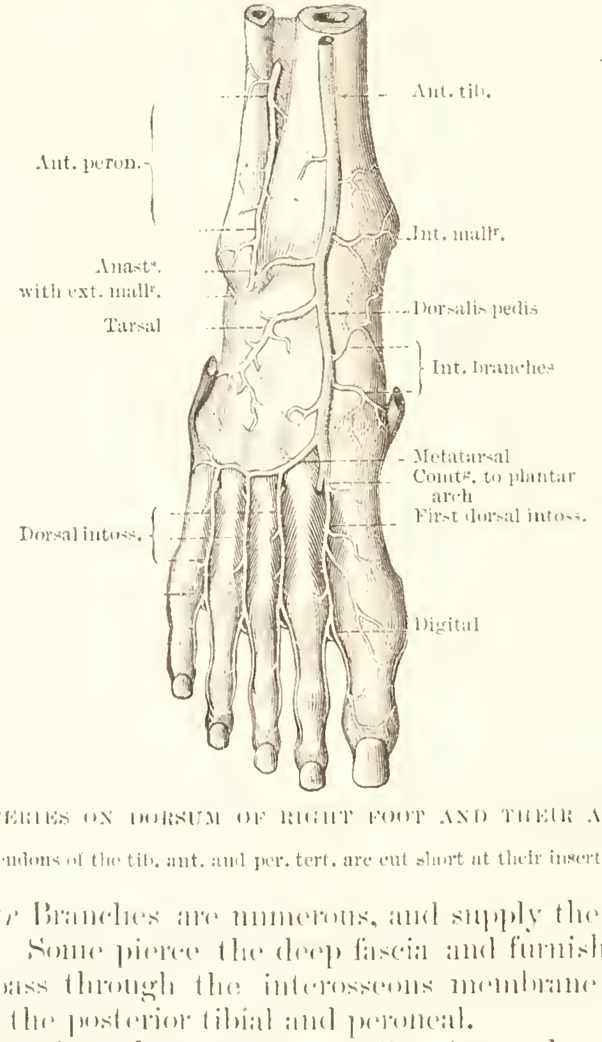


FIG. 126. ARTERIES ON DORSUM OF RIGHT FOOT AND THEIR ANASTOMOSES.

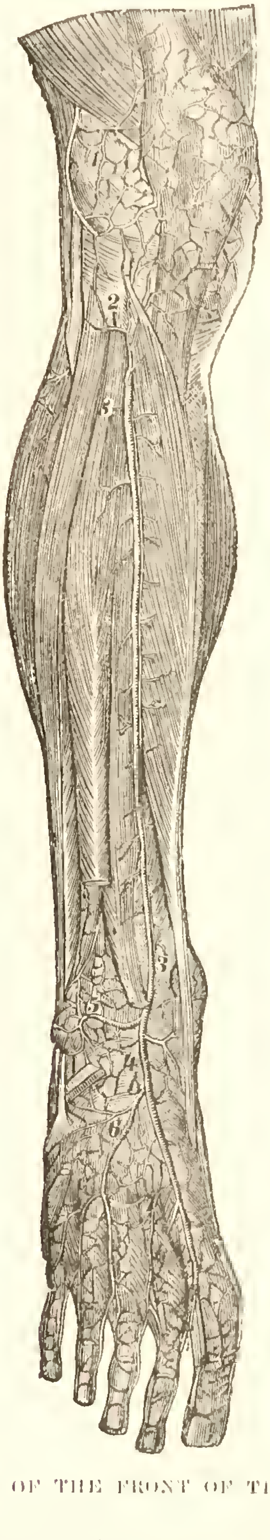
The tendons of the tib. ant. and per. tert. are cut short at their insertion.

The *Muscular* Branches are numerous, and supply the muscles of the front of the leg. Some pierce the deep fascia and furnish the cutaneous arteries, others pass through the interosseous membrane and inosculate with branches of the posterior tibial and peroneal.

The *Cutaneous* Branches are given off at intervals, either from the

main trunk or from its muscular branches. The largest of these accompany the musculo-cutaneous nerve, where it pierces the deep fascia.

The *Malleolar* Arteries are external and internal, and supply the ankle



1. Sup. ext. artic^{r}.
2. Ant. tib. recurrent.
3, 3. Ant. tib. giving off muscular on each side.
4. Dorsalis pedis, giving off in first interosseous space the anastomotic branch to plantar arch.
5. Ext. mall^{r}., nearly opposite which is the int. mall^{r}.
6. Tarsal branch of dorsalis pedis, larger than usual.
7. Metatarsal, giving off dorsal interosseous.
8, 8. Collateral digitals. The tib. ant^{s}. is drawn inwards, and the ext. prop. hall., ext. long. dig., per^{s}. tert^{s}., and ext. brev. dig. have been wholly or partly removed.

FIG. 127.—ARTERIES OF THE FRONT OF THE RIGHT LEG AND FOOT.

joint. The *internal* is given off about two inches above the joint, but is irregular in size and origin. It passes beneath the tendon of the tibialis anticus, and ramifies on the inner ankle, joining branches of the posterior

tibial, anterior peroneal, and internal plantar arteries. The *external* runs out beneath the tendons of the extensor longus digitorum and extensor pollicis, supplying the outer side of the ankle and anastomosing with the anterior peroneal artery, and with ascending branches from the tarsal branch of the dorsalis pedis.

Some small *articular* twigs pierce the anterior ligament of the ankle joint, and are given off from the lower end of the vessel.

The **Dorsalis Pedis Artery** is the continuation of the anterior tibial, and commences at the lower part of the anterior annular ligament, and passes to the back part of the first interosseous space, where it gives off two branches, the dorsalis pollicis and communicating.

Relations.—It rests upon the astragalus, scaphoid, and internal cunei-

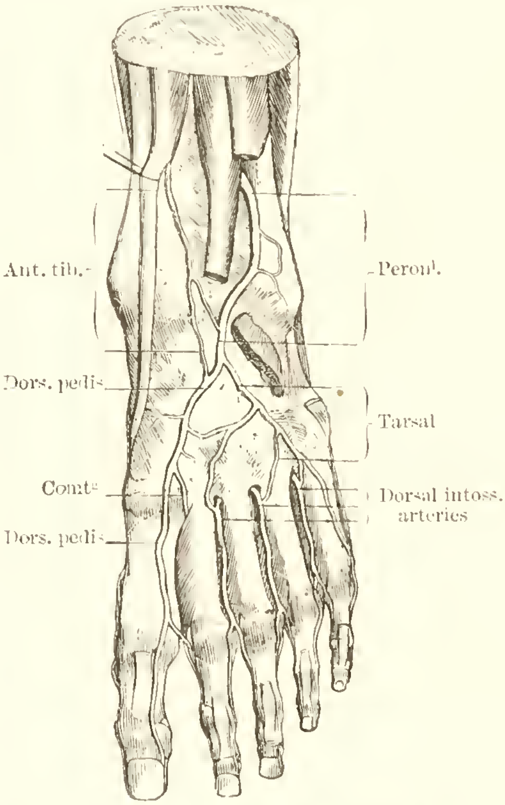


FIG. 428.—COMMON VARIETY OF DORSALIS PEDIS ARTERY. LEFT FOOT.

The anterior peroneal is much larger than ant. tibial, which it joins to form the dorsalis pedis.

form bones and their connecting ligaments. Above it are the skin, fascia, and the innermost tendon of the extensor brevis digitorum near its termination. At its inner side is the tendon of the extensor proprius pollicis, and at its outer the innermost tendon of the extensor longus digitorum and the end of the anterior tibial nerve. It has two venæ comites.

Branches.—These are mainly directed outwards and forwards upon the tarsus and metatarsus, and are named accordingly. A few twigs run obliquely inwards upon the inner side of the foot. A small interosseous branch supplies the first interosseous muscle.

The *Tarsal Artery* is usually given off opposite the scaphoid bone, but its point of origin may vary. It passes out upon the tarsal bones

under the extensor brevis digitorum and supplies that muscle and the tarsal joints, and anastomoses with the external plantar, the metatarsal, peroneal, and external malleolar arteries.

RELATIONS OF THE DORSALIS PEDIS ARTERY.

In front.—Skin, fasciæ, and innermost tendon of the extensor brevis digitorum.

Inside.—Extensor proprius pollicis	Dorsalis Pedis Artery	*Outside.* — Extensor longus digitorum and anterior tibial nerve.

Behind.—The astragalus, scaphoid, internal cuneiform, and their ligaments.

The *Metatarsal Branch* arises between the base of the metatarsal bones, passing out beneath the short extensor. Occasionally there are two metatarsal vessels, the second being the smaller, and commonly when there is but a single metatarsal vessel it arises in common with the tarsal artery. Its direction will vary according to its point of origin, being oblique when it arises far back and nearly transverse if it be given off further forwards than usual. It anastomoses with the external plantar and tarsal arteries, and gives off the interosseous branches.

The *Interosseous Vessels* are three in number, and are given off from the convexity of the metatarsal arch. They are small straight vessels which pass upon the three outer dorsal interossei, and divide slightly behind the clefts of the toes into two *dorsal collateral* branches for the adjoining toes. The outermost of these vessels sends off a small branch to the outer side of the little toe. At the fore part of each interosseous space they are joined by the *anterior perforating* branches from the digital arteries of the plantar arch, and at the back part of each interosseous space they receive the *posterior perforating* branches from the plantar arch. They supply the interossei muscles.

The *Dorsal Artery* of the great toe (dorsalis hallucis) passes forwards from the dorsalis pedis at the point where the latter dips down to the sole. It passes along the outer border of the first metatarsal bone to the cleft between the first and second toes, and divides into two branches, the inner one passing beneath the tendon of the extensor pollicis to the inner border of the great toe, the other branch bifurcating to nourish the adjacent sides of the great and second toes.

The *Anterior Tibial and Dorsalis Pedis veins* have similar extent and connections to the arteries they accompany. They form loops around the vessels by cross branches and receive branches corresponding to those of the artery, and communicate with the internal saphenous vein. They join the posterior tibial to form the popliteal vein. The valves in the deep veins of the leg are numerous, ten or a dozen being found between the knee and heel.

Dissection.—Cut through the tendons of the extensor longus digitorum and peroneus tertius below the annular ligament, and throw them towards the toes. The extensor brevis digitorum will then be exposed.

The **Extensor Brevis Digitorum** is a short muscle extending from the outer to the inner side of the foot. It *arises* from the outer side of the os calcis in front of the groove for the peroneus brevis, from the horizontal band of the anterior annular ligament and from the external calcaneo-astragaloid ligament. The four fleshy bellies of this muscle end in four tendons, the innermost belly and tendon being the largest, and is *inserted* into the base of the first phalanx of the great toe, crossing the dorsalis pedis artery. The other three tendons are joined to the *outer* sides of the long extensor tendons for the second, third, and fourth toes.

Relations.—Above it are the skin and fascia of the dorsum of the foot and the tendons of the extensor longus digitorum and proprius pollicis. Beneath it are the tarsal and metatarsal bones, and the dorsal interossei, and its innermost tendon crosses above the dorsalis pedis artery.

Nerve.—The anterior tibial.

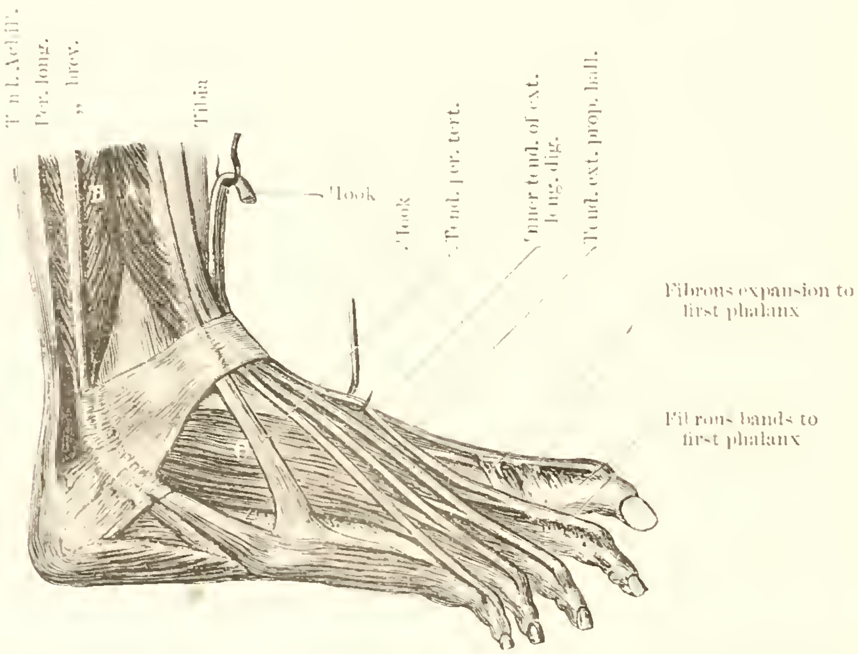


FIG. 429.—DISSECTION OF RIGHT FOOT AND TOES TO SHOW THE ATTACHMENTS OF THE TENDONS OF THE EXT. LONG. DIG. AND PROP. HALL. TO THE FIRST PHALANGES.

The bands are strong and short, and are covered by longer and thinner expansions, which pass to the sides of the first phalanges. External view. C. Ext. brev. dig. The ant. and ext. ann. ligs., abd. min. dig., and part of flex. brev. dig. are shown.

Actions.—It extends the four inner toes, and slightly separates them from each other. Its inner tendons act only on the first phalanx of the great toe. Being attached obliquely to the tendons of the long extensor it counteracts the oblique movement of the latter, so that both muscles acting in unison the toes are evenly extended.

Varieties.—It is occasionally bicipital, one head arising from the third metatarsal, the other from the calcis. One of its fleshy bellies may be absent, or one of its tendons, commonly that for the second toe, may be divided into two: sometimes there is a fifth tendon for the little toe. Rarely, a thin accessory muscle, the *indicator pedis*, is present between its two inner tendons. This extends the second toe.

Dissection.—Divide the extensor brevis towards its front and reflect it.

Cut through the horizontal band of the annular ligament over the extensor hallucis and reflect it, so as to demonstrate the sheaths in this ligament and its attachments. Follow to their origin the anterior tibial and musculo-cutaneous nerves and their branches.

Nerves on the Front of the Leg.—The **External Popliteal**, or peroneal nerve, about an inch below the head of the fibula, pierces the origin of the peroneus longus and divides between that muscle and the fibula into

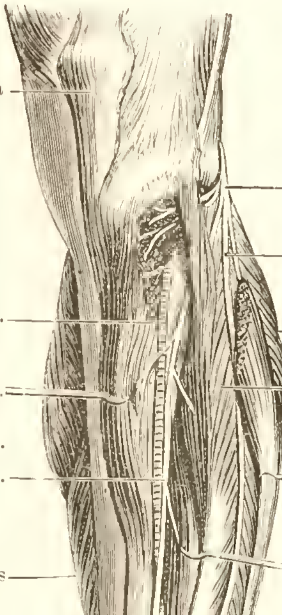


FIG. 430.—DISSECTION OF THE FRONT OF THE LEFT LEG AND DORSUM OF FOOT.

the anterior tibial and musculo-cutaneous. Before dividing it gives off articular and cutaneous branches which have already been described.

The *Recurrent*, or third articular nerve, is given off at the point of division of the peroneal nerve, and accompanies the tibial recurrent artery through the tibialis anticus muscle to the front of the knee, which it supplies.

The *Anterior Tibial Nerve* (anterior interosseous) passes obliquely forwards under the extensor longus digitorum to the front of the interosseous membrane, and reaches the outer side of the tibial artery about the middle of the leg; it then crosses the anterior tibial vessels once or more, and at the ankle joint is external to them. It there divides into an external and internal branch. Its branches are, muscular to the tibialis anticus, extensor longus digitorum, peroneus tertius, and extensor proprius pollicis, and the two terminal branches just mentioned.

FIG. 131. ARTERIES ON DORSUM OF RIGHT FOOT.

The *External or Tarsal Branch* passes out across the tarsus beneath the extensor brevis, and becoming ganglionic, like the posterior interosseous at the wrist, supplies the extensor brevis and the joints of the tarsus and metatarsus.

The *Internal Branch* is the continuation of the nerve, and accompanies the dorsalis pedis artery, and at the fore part of the first interosseous space divides into two branches that supply the contiguous sides of the

great and second toes, communicating with the internal branch of the musculo-cutaneous nerve.

The **Musculo-cutaneous Nerve** runs between the peronei and extensor longus digitorum to the junction of the middle and lower thirds of the leg, where it pierces the deep fascia on its front and outer side, and divides into two branches, internal and external, which are distributed to the dorsum of the foot and toes. Before piercing the fascia it supplies the peroneus longus and brevis, and then gives off some cutaneous filaments to the lower and outer part of the leg.

The *Internal Branch* of the musculo-cutaneous crosses the ankle joint, passes along the inner side of the dorsum of the foot, and supplies the

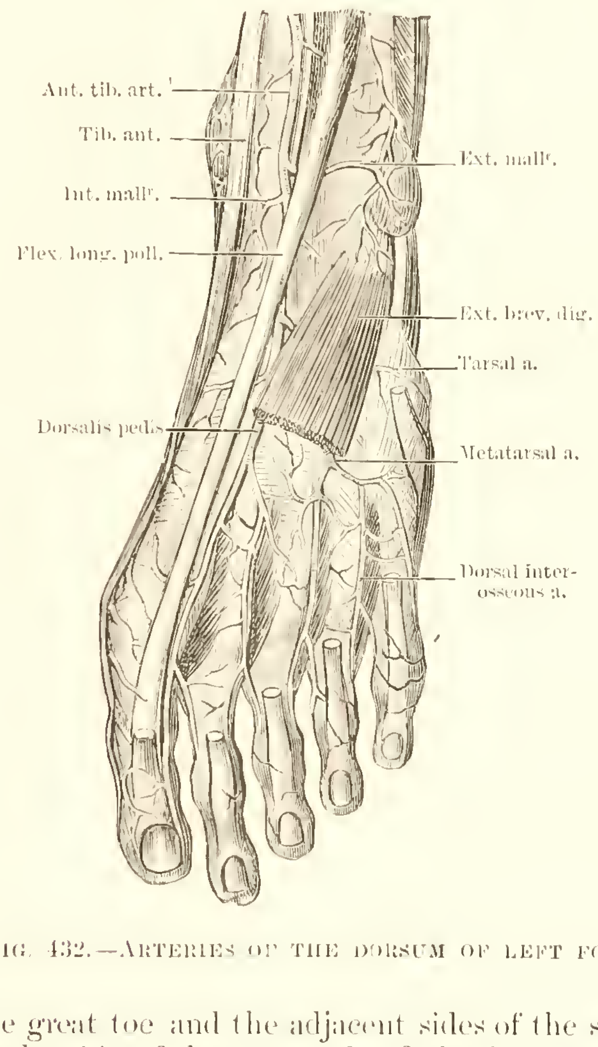


FIG. 432.—ARTERIES OF THE DORSUM OF LEFT FOOT.

inner side of the great toe and the adjacent sides of the second and third; it also supplies the skin of the inner side of the foot and inner ankle, and joins the internal saphenous nerve on the inner side of the foot, and the anterior tibial between the first and second toes.

The *External Branch* is the larger, and passes along on the outer side of the dorsum of the foot to the adjoining sides of the third, fourth, and fifth toes. It also innervates the skin of the outer side of the foot and outer ankle, and joins the short saphenous nerve.

The distribution of these digital nerves of the musculo-cutaneous is variable, commonly they supply all the toes on the dorsal aspect excepting

the adjacent sides of the great and second toes, which are furnished by the anterior tibial, and the outer side of the little toe, which is innervated by the short saphenous. The dorsal digital nerves should be traced to the last phalanges of the toes, where they will be found to unite with each other and to give off filaments to the bed of the nail.

Muscles on the Outer Side of the Leg.—There are two muscles in

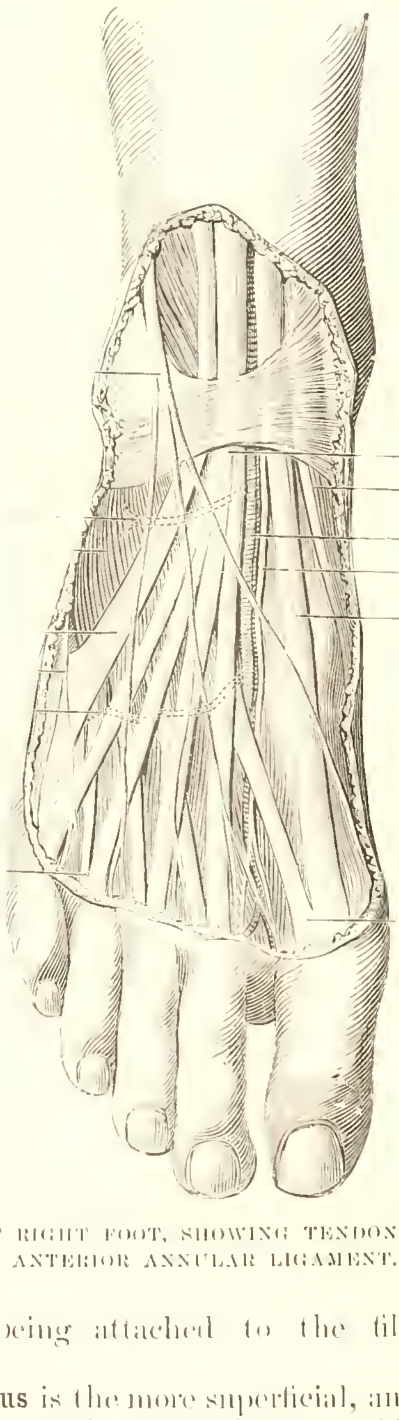


FIG. 433.—DORSUM OF RIGHT FOOT, SHOWING TENDONS, VESSELS, NERVES, AND ANTERIOR ANNULAR LIGAMENT.

this position, which being attached to the fibula have been named *peronei*.

The **Peroneus Longus** is the more superficial, and occupies the upper and outer side of the leg. It *arises* from the outer side of the head and upper two-thirds of the anterior surface of the shaft of the fibula, from the intermuscular septa, from the deep fascia, and from the external border of the

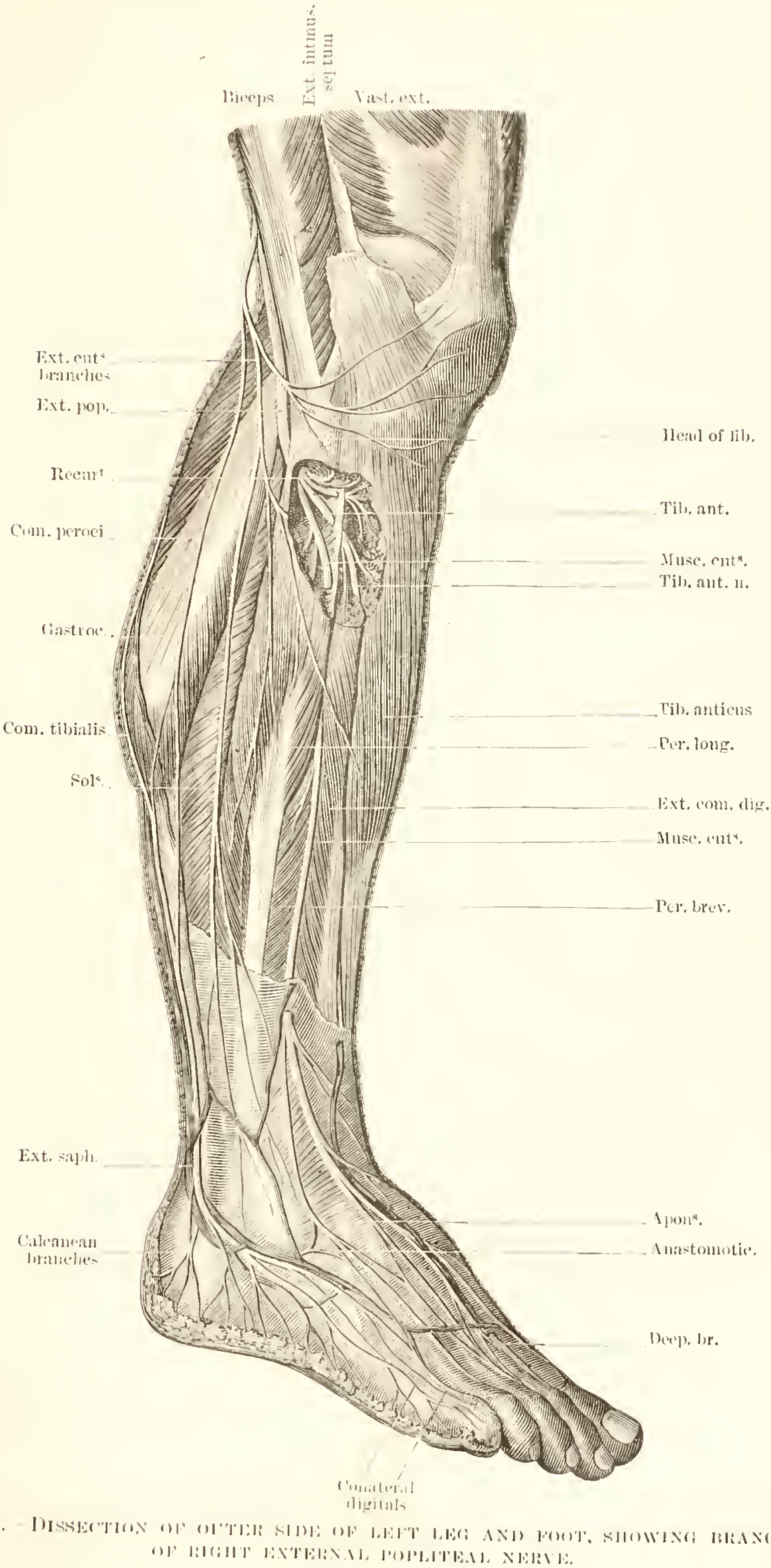


FIG. 434.—DISSECTION OF OUTER SIDE OF LEFT LEG AND FOOT, SHOWING BRANCHES OF RIGHT EXTERNAL POPLITEAL NERVE.

fibula nearly to the malleolus. It ends in a long tendon which passes behind the outer malleolus, beneath the external annular ligament, in a groove which is common to it and the peroneus brevis. It then passes obliquely forwards across the outer side of the os calcis, below the peroneus brevis, and in a separate fibrous sheath. Then it runs in a slight groove on the outer side of the cuboid, and finally in a deep groove on the under surface of that bone, which groove is converted into a canal by the long calcaneo-cuboid ligament, and is *inserted* into the internal cuneiform and

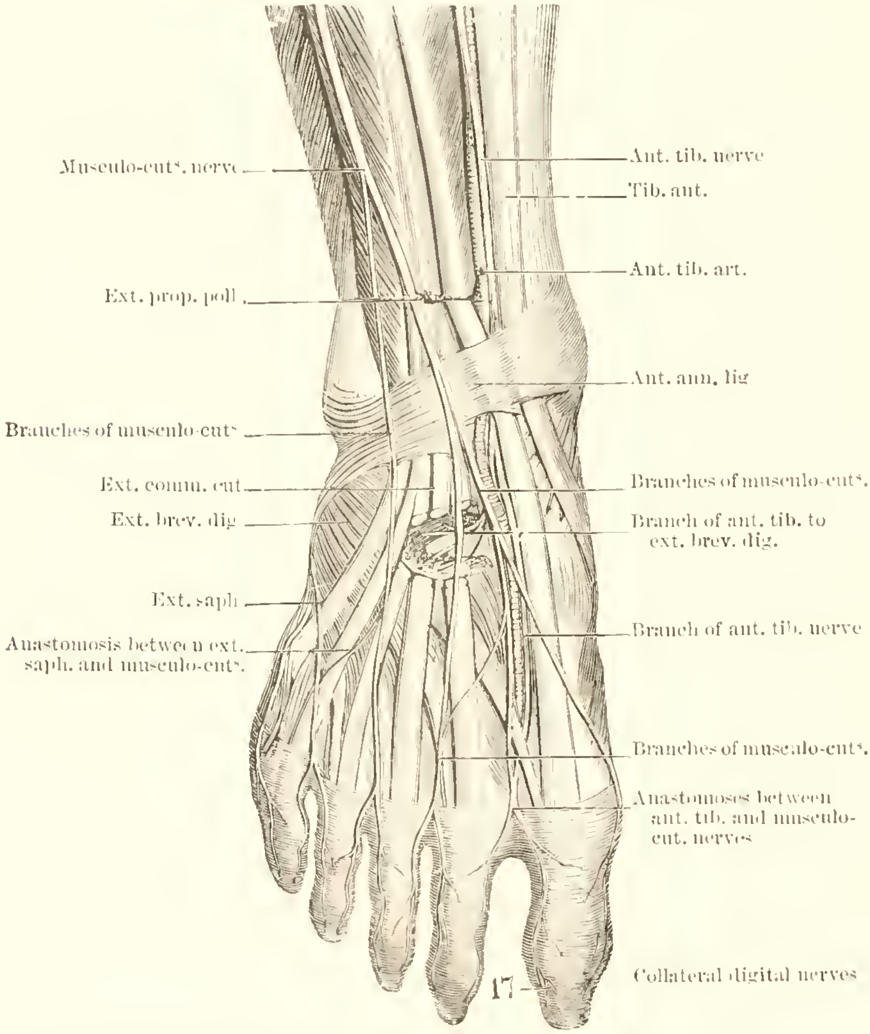


FIG. 435.—TERMINATIONS OF THE ANTERIOR TIBIAL AND MUSCULO-CUTANEOUS NERVES AND ANTERIOR TIBIAL ARTERY ON THE DORSUM OF THE RIGHT FOOT.

base of the first metatarsal bone. This portion of the muscle has been seen in the dissection of the sole.

Relations.—In the leg it is immediately beneath the fascia and rests on the peroneus brevis. Its tendon rests on the middle piece of the external lateral ligament of the ankle with that of the peroneus brevis, one synovial membrane being common to both tendons. In *front* of it is the origin of the extensor longus digitorum, and the soleus is attached to the fibula *behind* it.

Action.—It extends the foot upon the leg and raises its outer border.

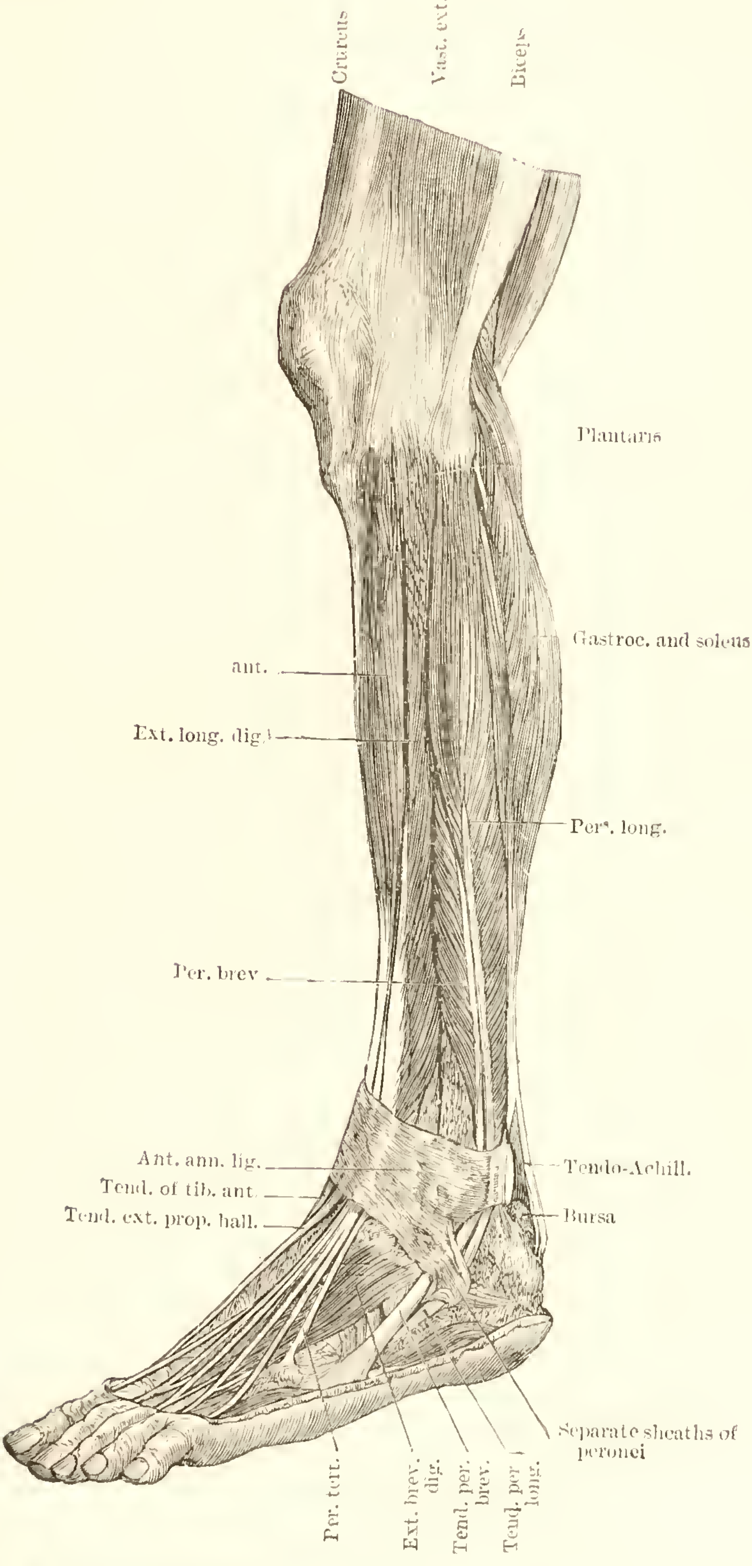
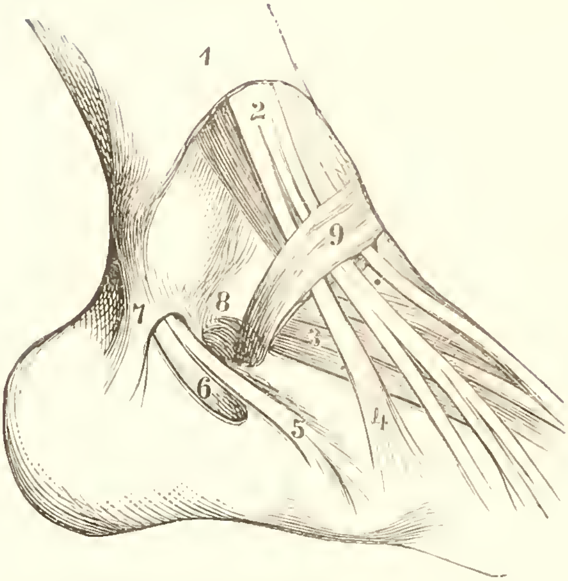


FIG. 436.—EXTERNAL MUSCLES AND TENDONS OF LEFT LEG.



1. Skin.
2. Ext. dig. long.
3. Ext. dig. brev.
4. Peron. tertius.
5. Peron. brev.
6. Peron. long.
7. Ext. ann. lig.
8. Sinus tarsi.
9. Ant. annular lig.

FIG. 137.—ANTERO-EXTERNAL TENDONS OF RIGHT FOOT. ONE-HALF.

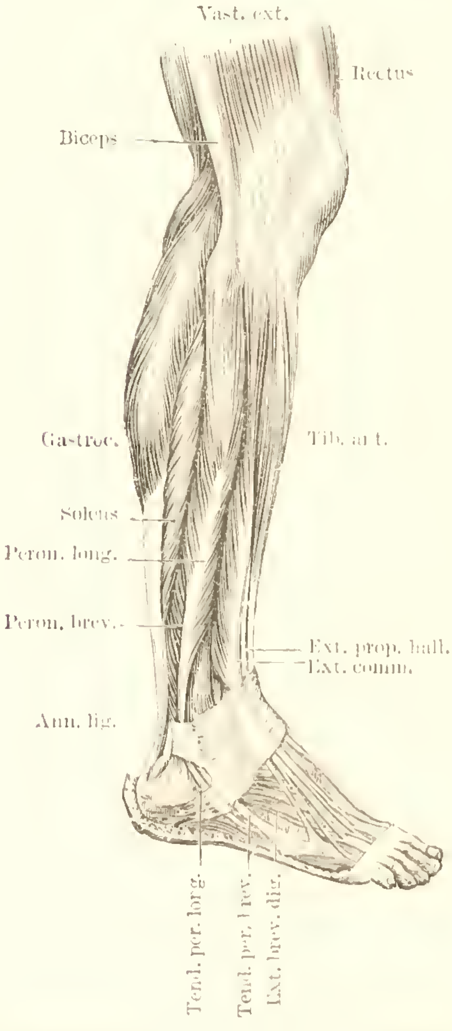


FIG. 138.—MUSCLES OF RIGHT LEG. EXTERNAL VIEW.

The foot being on the ground it will steady the leg upon the foot, and will assist to lift the hinder part of the body weight, as in walking, &c.

Nerve.—The musculo-cutaneous.

Varieties.—There is often a tendinous slip for the third metatarsal, and sometimes others for the fourth, fifth, and even for the base of the first metatarsal. There is an occasional small head of origin from the fibula between it and the brevis. This is the *peroneus accessorius*, and its tendon usually joins that of the longus.

The **Peroneus Brevis** is beneath the longus and is smaller and shorter than it. It *arises* from the anterior and posterior borders of the fibula,

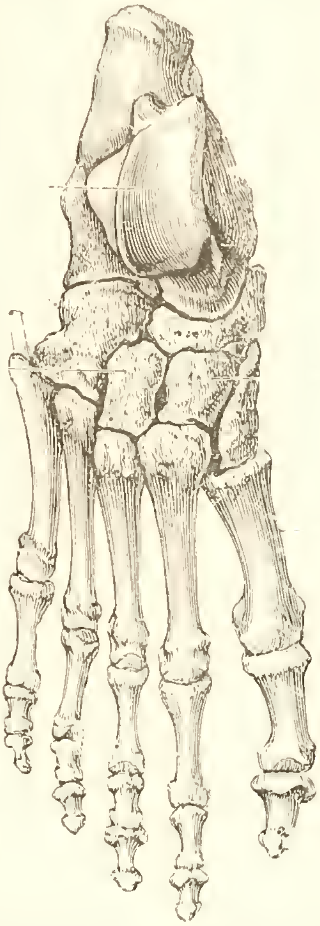


FIG. 439.—SHOWING THE BONES OF THE RIGHT FOOT (DORSAL ASPECT) AND THE INSERTION OF THE PERONEUS BREVIS.

and from the lower two-thirds of the anterior surface of its sheath, internal to the longus; also from the intermuscular septa and deep fascia. Its fibres pass vertically downwards and end in a tendon which is placed in *front* of that of the longus; this passes, with the tendon of the peroneus longus, through the same groove beneath the external malleolus and under the external annular ligament, being enclosed in the same synovial membrane. It then passes through a separate fibrous sheath on the outer side of the os calcis *above* the tendon of the longus, and is inserted into the dorsal surface of the base of the metatarsal bone of the little toe on its outer side.

Relations.—In the leg it reaches a little in front of the longus which

covers it, and its *deep* surface is in contact with the fibula and outer side of the os calcis.

Actions.—It extends the ankle and turns the foot up and out in eversion. Its other actions resemble those of the longus, which it assists in drawing back the fibula in the act of rising from stooping.

Nerve.—The musculo-cutaneous.

Varieties.—The peroneus brevis may send a fibrous expansion to the fourth dorsal interosseous muscle, or a muscular fasciculus to the tendons of the common extensor of the toes. There may be a *peroneus accessorius* arising from the fibula, between the longus and brevis, and joining the tendon of the brevis in the sole. A *peroneus quinti digiti* may exist arising from the lower fourth of the fibula under the brevis, or from the

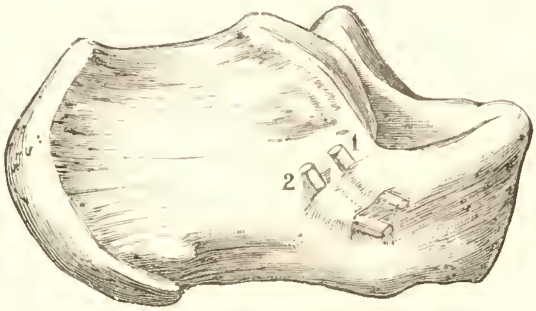


FIG. 440.—RIGHT OS CALCIS SEEN ON ITS OUTER ASPECT TO SHOW THE PERONEI TENDONS IN THEIR SHEATHS.

1. Peroneus brevis. 2. Peroneus longus.

tendon of the brevis, and inserted into the expansion on the dorsum of the little toe. A *peroneus quartus* arising between the flexor hallucis and peroneus brevis on the back of the fibula, and inserting into a tubercle on the os calcis behind the ordinary peronei tendons, may be present. A *peroneus quintus* may be given off from the brevis and be inserted close behind the quartus. A muscular fasciculus, which has been named the *tensor membranæ synovialis tarsi*, may be given off from the lower part of the brevis, and be inserted into the under part of the retinacula or sheath of the peronei tendons.

Directions.—The student should now proceed with the dissection of the ligaments of the leg and foot.

TIBIO-FIBULAR ARTICULATIONS.

Dissection.—Remove the muscles on both surfaces of the interosseous membrane, and from the front and back of the upper and lower ends of the tibia and fibula, where they articulate.

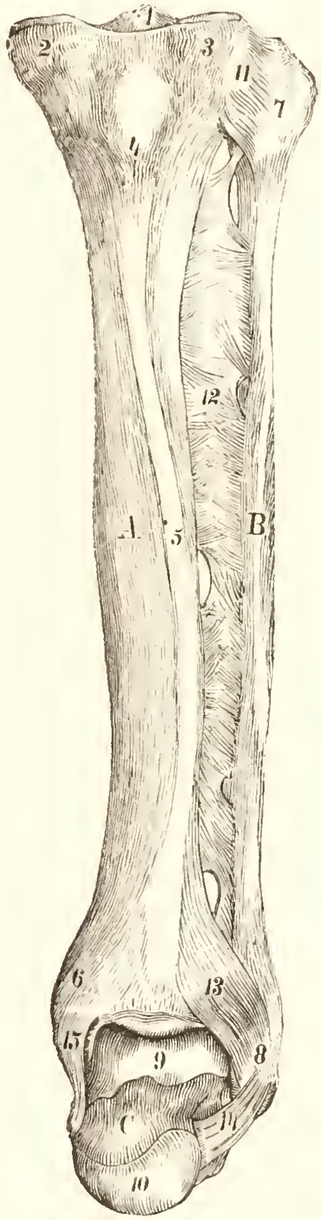
The tibio-peroneal articulations are the superior and inferior. In the middle, between the bones is the interosseous ligament, and the upper and lower ligaments are fibrous bands at the extremity of the bones.

Superior Tibio-fibular Joint.—This articulation is an arthrodial one, and resembles the lower in being almost immovable. Its ligaments are anterior and posterior. The *superior anterior ligament* consists of two or three broadish flat bands, which run across the joint from the outer tuberosity of the tibia to the head of the fibula.

The *superior posterior ligament* is broad, and thinner than the anterior, and crosses the joint from the outer tuberosity of the tibia to the head of the fibula. The tendon of the popliteus lies on it.

Dissection.—Remove these ligaments to observe the synovial membrane and the articular surfaces.

The *synovial membrane* lines this articulation, and at its back projects



A. Tibia.
B. Fibula.
C. Astragalus.
1. Spine of tibia.
2. Int[l]. tuberosity.
3. Ext. „
4. Tubercle.
5. Crest.
6. Int. mall[s].
7. Head of fib.
8. Ext. mall[s].
9. Trochlea of astrag.
10. Head „
11. Ant. sup. tib. fib. lig.
12. Intoss. lig. showing apertures for vessels.
13. Ant. inf. tib. fib. lig.
14. Ext. lat[l]. ant. piece.
15. Int. „ „

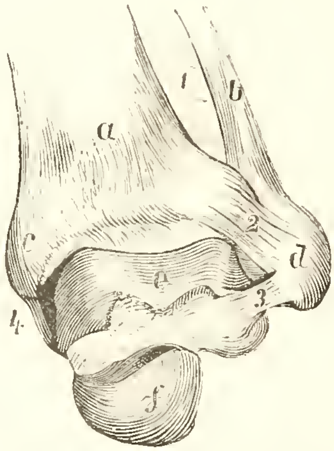
FIG. 441.—THE TIBIO-FIBULAR LIGAMENTS OF THE LEFT LEG SEEN FROM THE FRONT. ONE THIRD.

up so as to touch that of the knee, with which it is sometimes continuous at the upper and back part. The articular surfaces are both flat and oval, and covered with cartilage.

Middle Tibio-fibular Articulation. — The *interosseous membrane* or *ligament* fills the space between the bones except at their upper and lower parts. It is a thin aponeurotic lamina of oblique fibres, which for the

most part pass down from the external border of the tibia to the oblique line on the inner fibular surface at its upper two-thirds, and to the posterior edge of the fibula along the lower third. Some fibres cross in the opposite manner. This ligament is broader above than below, and in its upper part there is an oval aperture about an inch in length, near the neck of the fibula, for the passage of the anterior tibial artery to the front of the leg; and at its lower part, about an inch above the lower edge of the fibula, is a small opening for the anterior peroneal vessels. Below, it is continuous with the inferior interosseous ligament; and it is perforated in numerous places along its length for the passage of small vessels. It separates the muscles in front from those at the back of the leg, the former being the tibialis anticus, extensor longus digitorum, extensors proprius pollicis and peroneus tertius, with the anterior tibial vessels and nerve. The latter are the tibialis posticus and flexor longus pollicis.

Inferior Tibio-fibular Joint.—The ligaments of this articulation are



a. Tibia.
b. Fibula.
c. Int. mall^s.
d. Ext. „
e. Trochlea of astrag.
f. Head of astrag.
1. Intoss. lig.
2. Ant. inf. tib. fib. lig.
3. Ext. lat^l. ant. piece.
4. Int. „ „

FIG. 142.—LEFT ANKLE JOINT OPENED. ANTERIOR ASPECT.

four: anterior and posterior, inferior tibio-fibular or inferior interosseous, and transverse.

The *anterior inferior ligament* is a flat triangular band, broader below than above, and extends obliquely down and out over the front of the articulation, between the contiguous margins of the tibia and fibula. In *front* it is in relation with the peroneus tertius, deep fascia of the leg and skin. *Behind*, with the inferior interosseous ligament, and is also in contact with the cartilage covering the upper anterior part of the astragalus.

The *posterior inferior ligament* is smaller than the anterior, and has similar connections behind the articulation.

The *inferior ligament* of this articulation, called the *inferior interosseous*, to distinguish it from the interosseous ligament or membrane between the tibia and fibula, consists of many strong, short, transverse, yellowish fibrous bands, distinct from the posterior ligament, which fill the space between the contiguous rough surfaces of the tibia and fibula, and form their chief bond of union. It is attached to the end of the fibula above the small pit, and to the contiguous part of the tibia and posterior border of the articulation, and assists in deepening the hollow for the

reception of the astragalus. It is continuous above with the interosseous membrane.

The *transverse ligament* is a longish, narrow band continuous with the posterior inferior ligament, and passes transversely over the posterior aspect of the joint, from the posterior border of the external malleolus to the outer margin of the tibia, near its malleolar process. This ligament projects below the margin of the bones, and is said by some to be only a part of the inferior interosseous ligament.

The *synovial membrane* is an extension from that of the ankle joint.

Joint Surfaces.—The lower ends of the tibia and fibula are in contact by surfaces which are mainly rough and connected by ligament, but near their lower borders are smooth and covered by cartilage. The fibular surface is convex, and the tibial concave; the lower edges of both being straight.

Movements.—The tibio-fibular articulations permit of little movement, as the main use of the fibula is to give attachment to the leg and foot muscles, and to support the ankle joint externally. In the *upper* articulation only slight antero-posterior gliding can take place. In the *lower* the ligament and the elasticity of the fibula allow slight yielding to the pressure of the astragalus when the body weight is thrown on the inner side of the foot. If the force acting in this direction be too great, the lower third or fourth of the fibula will fracture rather than the ligament yield; and in falls upon the feet, the astragalus may be driven up between the two bones. This accident is extremely rare; I have seen but one case, which occurred at the Middlesex Hospital some years ago in the practice of Mr. Nunn.

THE ANKLE JOINT.

This, like the knee, is a ginglymus or hinge joint. The tibia and its malleolus, and the external malleolus of the fibula, form an arch which receives the upper convex surface of the astragalus and its two lateral facets. There are four ligaments, viz. anterior, posterior, internal and external lateral.

Dissection.—Remove the muscles, vessels, and fibrous tissue from the front and back of the joint, and to define the lateral ligaments, the leg must be placed first on one and then on the other side. The tibialis posticus and the peronei muscles, with the remains of the annular ligaments, must be taken away. The student should study the action of these ligaments in the various movements of the joint, and must refer to the paragraph a little further on which deals with that subject.

The *Anterior or Tibio-astragaloid* is a broad thin membrane which is attached above, close to the articular edge of the tibia, and below, to the upper margin of the astragalus in front of its tibio-articular surface. It is pierced by vessels, and is continuous at the sides with the lateral ligaments. *In front*, it is in relation with the extensor tendon of the toes, the tibialis anticus, peroneus tertius, and anterior tibial vessels and nerve. *Behind*, it is in contact with the synovial membrane.

The *Posterior Ligament*, when present, is thicker externally than internally, and has similar connections to the leg bones as the anterior, but

at the back of the joint. At its outer part it is made up of transverse fibres which are fixed to the depression on the inner surface of the outer malleolus.

The *Transverse Ligament* of the inferior tibio-fibular joint is said by some to take the place of the posterior ligament. The anatomists who

1 External malleolus.
2. Anterior fasciculus of external lateral ligament.
3. Middle, and
4. Posterior fasciculi.
5. External calcaneo-cuboid.
6. Cubo-metatarsal.

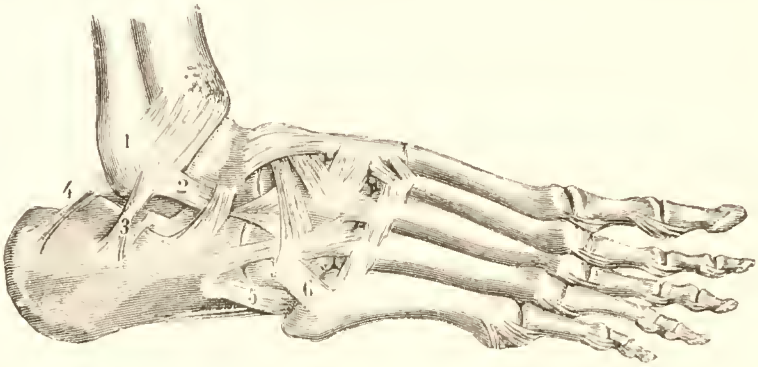


FIG. 443.—LIGAMENTS OF THE RIGHT FOOT. OUTER ASPECT.

describe a posterior ligament to the ankle, omit a transverse ligament to the tibio-fibular joint.

The *internal lateral or deltoid ligament* has two layers, superficial and deep. The *superficial layer* is a triangular strong flat membrane, which is attached above to the apex and anterior and posterior borders of the internal malleolus. The *anterior* fibres pass forwards to be attached

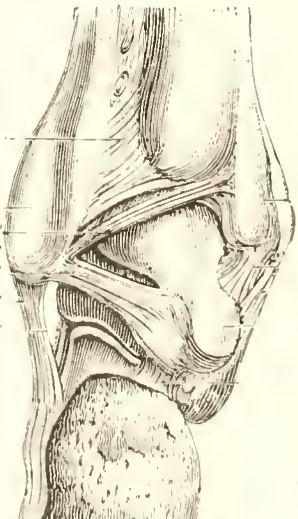
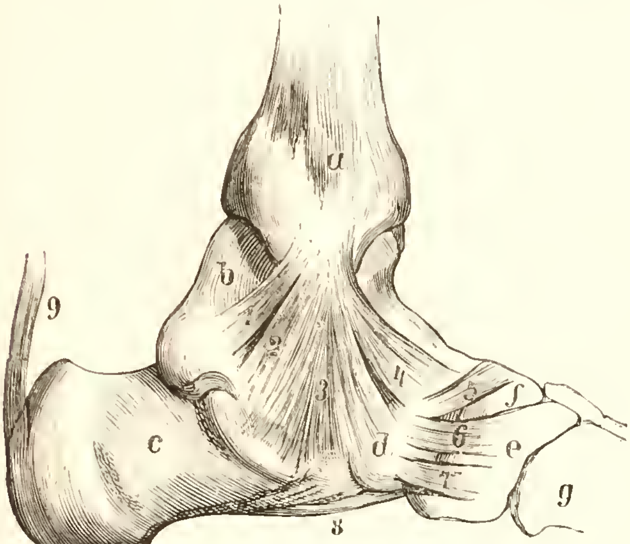


FIG. 444.—LIGAMENTS ABOUT THE ANKLE. LEFT FOOT, POSTERIOR VIEW.

to the scaphoid, joining the inferior calcaneo-scaphoid ligament. The *middle* fibres descend vertically to be fixed to the sustentaculum tali of the os calcis; and the *posterior* pass back and out, to be attached to the hinder part of the astragalus. The *deeper layer* is made up of strong, short, thick fibres, which pass from the groove on the under surface of the apex and from the apex of the malleolus to below the articular surface

of the astragalus. On this ligament lie the tendons of the tibialis posticus and flexor longus digitorum.

The *external lateral ligament* consists of three separate bands separated by distinct intervals, and taking different directions. They are



a. Tibia.
b. Astragalus.
c. Os calcis.
d. Scaphoid.
e. Int. cuneiform.
f. Middle cuneiform.
g. First metatarsal.
1. Post.
2. Middle, and
3. Anterior pieces of int. lat. lig.
4. Tibio-scaphoid.
1 2 3 4 constitute together the int. lat. or trapezoid lig.
5. Dorsal scapho-cuboid.
6 7. Dorsal scapho-cuneiform.
8. Long. calc.-cuboid.
9. Tendo-Achillis.

FIG. 445.—INTERNAL LIGAMENTS OF THE LEFT FOOT. ONE-HALF.

called the anterior, middle, and posterior portions of the ligaments, but some anatomists have considered them as three distinct ligaments, and they have received names corresponding to their attachments.

The *anterior fasciculus* is the shortest, and runs from the anterior

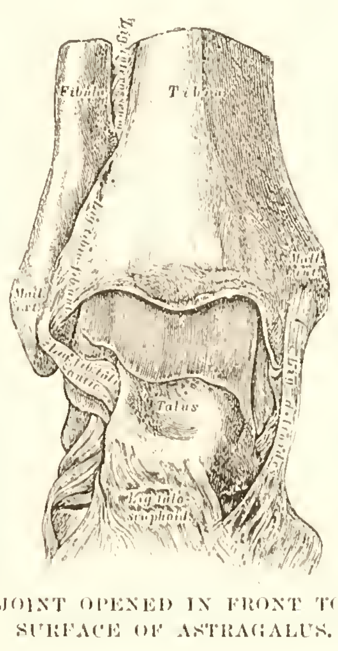


FIG. 446. LEFT ANKLE JOINT OPENED IN FRONT TO SHOW UPPER ARTICULAR SURFACE OF ASTRAGALUS.

edge of the summit of the external malleolus, forwards and downwards, to the side of the astragalus, in front of its lateral articular surface for the os calcis.

The *middle fasciculus* is the longest, is narrow and round, and passes

from the apex of the malleolus down and back to the middle of the outer surface of the os calcis. The tendons of the peroneus longus and brevis rest on it.

The *posterior fasciculus* is the most deeply placed, and the strongest. It is almost horizontal, and passes from the depression at the inner and back part of the outer malleolus to the astragalus behind its upper articular surface and that for the external malleolus. The peronei tendons lie on this fasciculus also. This portion of the ligament helps to deepen the cavity for the astragalus.

Dissection.—Divide the ligaments and separate the bones, to see the synovial membrane and the articular surfaces.

The *synovial membrane* covers the inner surface of the ligament, and sends a fold upwards between the lower ends of the tibia and fibula. The middle part of the external lateral ligament is only slightly in contact above with the synovial membrane.

Articular Surfaces.—On the lower end of the tibia there are two cartilaginous articular facets, one for the shaft and the other for the malleolus. The inner surface of the fibular malleolus is covered with cartilage for articulation with the astragalus. This malleolus is longer and placed further back than the inner.

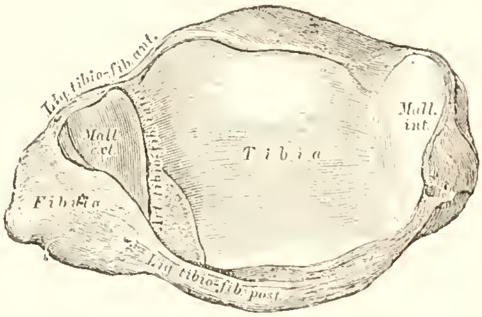


FIG. 417.—THE ARTICULAR SURFACES OF THE LEFT TIBIA AND FIBULA.

The *astragalus* has three cartilaginous facets for the ankle articulation, an upper and two lateral. The *upper* or *central* articular surface is, like the lower surface of the tibia, broader in front than behind, and trochlear-shaped. The outer facet is the larger of the lateral facets.

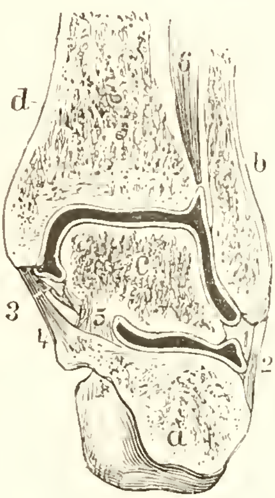
Movements.—The motions of this joint are, like those of other joints, mainly determined by the shape of the articular surfaces. *Flexion* and *extension* are the chief movements permitted in this joint. In *extension* the toes point to the ground, and in *flexion* they are raised towards the front of the leg.

In *extension* the astragalus moves forwards and projects anteriorly. This movement is stopped by the meeting of the astragalus with the tibia behind, and by the tension of the anterior ligament. The anterior portion of the external and the anterior and middle parts of the internal lateral ligaments are rendered tense. In complete extension, a certain amount of lateral motion is possible, because the narrow part of the astragalus is brought into the widest portion of the space between the malleoli; but if the extension be forced, the astragaloid portions of the lateral ligaments will prevent lateral motion in consequence of being rendered tense. *Extension* of the joint is accompanied with a slight in-

version of the toes, because the outer border of the superior articular surface of the astragalus is curved and longer than the inner.

The muscles producing *extension* are the gastrocnemius, soleus, plantaris, peroneus longus and brevis, flexor communis digitorum, tibialis posticus, and flexor longus hallucis.

In *flexion* the astragalus moves back and projects at the posterior part of the joint. Further motion in this direction is checked by the astragalus meeting the anterior edge of the tibia. The posterior ligament is stretched by the projecting body of the astragalus, and the posterior piece of the external lateral and middle and posterior fasciculi of the internal lateral ligaments are rendered tense. In complete flexion the broad part of the astragaloid surface is thrust back into the narrowest part of the intermalleolar space, and the inferior fibular extremity is pressed on, so as to render tense the inferior tibio-fibular ligaments. Lateral movement is thus prevented, but at the same time a certain amount of elasticity is gained.



a. Calcaneous.
b. Fibula.
c. Astragalus.
d. Tibia.
1. Post., and
2. Middle pieces of ext. lat. lig.
3 and 4. Similar portions of int. lat.
5. Intoss. The synovial cavities are shown.
6. Inf. intoss. lig.

FIG. 118.—VERTICAL TRANSVERSE SECTION THROUGH HINDER PART OF LEFT ANKLE AND FOOT, SEEN FROM BEHIND. ONE HALF. TO SHOW THE SYNOVIAL CAVITIES.

Flexion is produced by the tibialis anticus, extensor proprius hallucis, peroneus tertius, and extensor communis digitorum.

Abduction is brought about by the peroneus longus, brevis, tertius, and extensor communis digitorum.

Adduction is due to the action of the tibialis anticus and posticus, extensor proprius hallucis, and the triceps of the leg, i.e. the gastrocnemius, soleus, and plantaris.

Use of the Ligaments.—The internal lateral, or deltoid, is very strong, and will withstand a force which would break the internal malleolus. Its middle fasciculus, with that of the external lateral ligament, connects the leg bones strongly to the os calcis, and resists displacement in all directions. The anterior and posterior fasciculi of the deltoid ligament check extension and flexion of the foot, respectively; and the anterior fibres also limit abduction. The posterior portion of the external lateral ligament aids the middle in opposing dislocation of the foot backwards, and it also deepens the cavity for the astragalus. Its anterior fasciculus checks dislocation of the foot forwards, and limits extension and adduction.

Relations.—*In front*, from within out, are the tibialis anticus, extensor pollicis, extensor communis digitorum, and peroneus tertius, the anterior tibial vessels and nerve being between the extensors pollicis and digitorum, and the nerve being external to the artery.

Behind, from within out, are the tibialis anticus, flexor longus digitorum, posterior tibial vessels and nerve, and flexor longus pollicis. The tendons of the peroneus longus and brevis lie in the groove behind the external malleolus.

The *Arteries* to the joint are derived from the malleolar branches of the anterior tibial, and from the peroneal and dorsalis pedis.

The *Nerves* are supplied by the anterior tibial.

Dissection.—Remove all the soft parts, excepting the ligaments, which will be known by their glistening aspect, from the dorsum and the sole of the foot; and cleanse the connective tissue from between the ligamentous bands which connect the various tarsal, metatarsal, and phalangeal bones.

Articulations of the Tarsus.—These may be subdivided into three sets. (1) The joints of the first row of tarsal bones; (2) those of the second row; and (3) ligaments connecting the bones.

The *External Calcaneo-astragaloid Ligament* is a strong short band, which goes from the outer surface of the astragalus, just below its external malleolar facet, to the outer edge of the os calcis. It is parallel with, and situated in front of the middle fasciculus of the external lateral ligament of the ankle.

The *posterior Calcaneo-astragaloid Ligament* is made up of a few short narrow fibres, which pass obliquely back and in, between the posterior extremity of the astragalus and the upper adjoining surface of the os calcis. It is grooved by the tendon of the flexor longus pollicis.

The *Interosseous Ligament* is the chief bond of union between the bones. It is made up of numerous strong vertical and oblique fibres, fixed above to the groove between the astragaloid articular facets, and below to the corresponding depression on the upper surface of the os calcis. It is very strong and thick, and is an inch in breadth.

There are two synovial membranes, one for the anterior and the other for the posterior calcaneo-astragaloid joint. The anterior one passes between the head of the astragalus and the scaphoid.

Articular Surfaces.—The interosseous ligament must be cut through before these surfaces can be studied. There are two articular surfaces on both the astragalus and os calcis, the anterior and the posterior. The anterior one of the os calcis is concave, and occasionally divided into two; the posterior is convex transversely. The astragaloid surfaces have just the reverse shape to those of the os calcis, the anterior being convex, the posterior concave. The former one is placed on the under surface of the head of the astragalus, and is common to the astragalus, os calcis, and scaphoid. The synovial membrane very rarely communicates with that of the calcaneo-cuboid joint.

Movements.—In standing, the body weight forces the astragalus down and in, flattening the pedal arch, so that its head rests on the calcaneo-scaphoid ligament and the interosseous ligament is rendered tense. When the pressure is removed, the arch of the foot is restored and the astragalus is carried up and out by the elasticity of the ligaments. The interosseous astragalo-calcaneal ligament is the centre of the only kind of motion, i.e.

gliding, which is possible in these joints. This arthrodial motion is such, that when the posterior part of the os calcis glides in and up beneath the astragalus, or *vice versâ*, the astragalus passes down and out above the os calcis, and the cuboid extremity of the os calcis also moves down and out. The head of the astragalus is supported in standing by the tibialis posticus and flexor longus digitorum tendons: and the posterior, external, and calcaneo-scaphoid ligaments are stretched.

Articulations of the Second Row.—The scaphoid, cuboid, and three cuneiform bones are connected by dorsal, plantar, and interosseous ligaments.

The *dorsal ligaments* are small bands of parallel fibres passing from

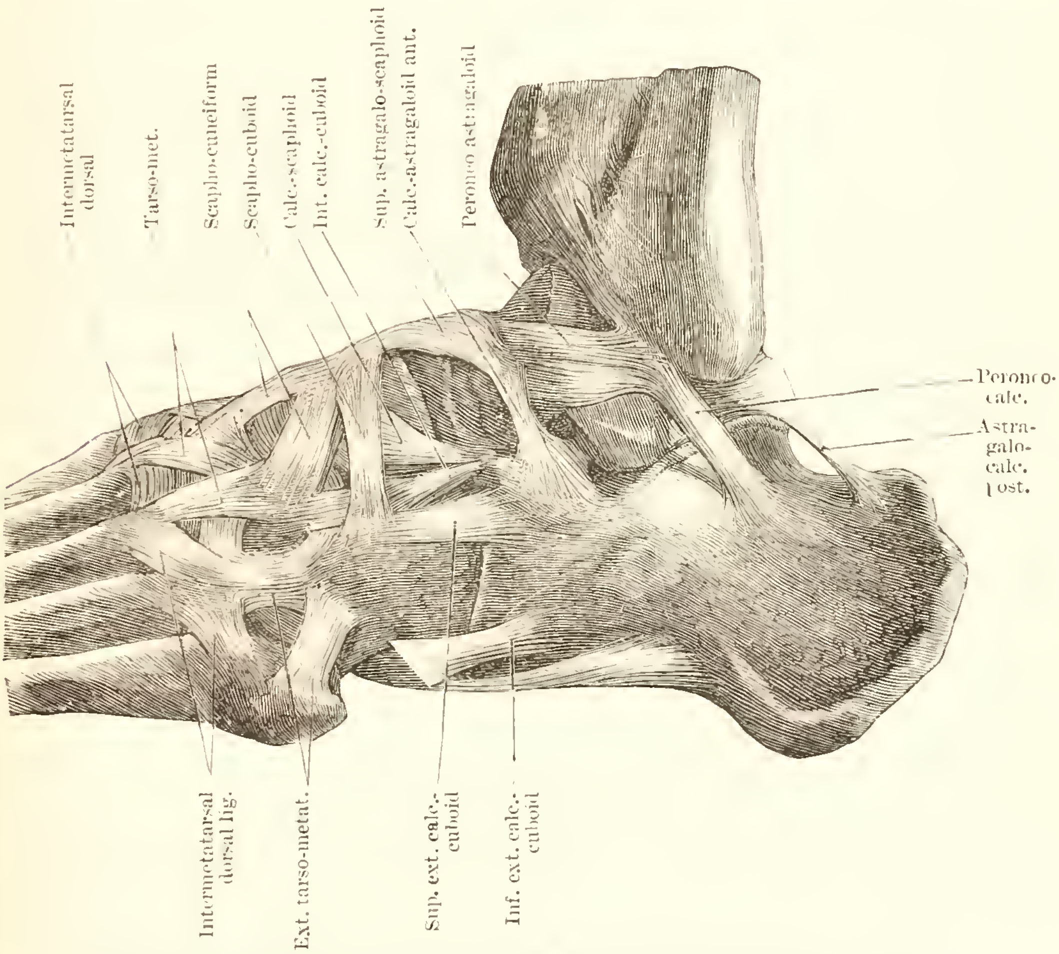


FIG. 119.—LIGAMENTS OF THE DORSUM AND OUTER SIDE OF LEFT FOOT

each bone to the one with which it articulates. Those between the os calcis and cuboid are less strong than the corresponding plantar ones. Those between the scaphoid and the three cuneiform are three longitudinal bands near to each bone, the innermost being the widest and strongest, and extending around the inside of the joint into the sole of the foot.

The *plantar ligaments* have a similar arrangement in the sole of the foot.

The *interosseous ligaments* are four, and consist of strong transverse fibres between the rough non-articular surfaces of the contiguous bones.

There is one between the scaphoid and cuboid; another between the internal and middle cuneiform; a third between the middle and external; and a fourth between the external cuneiform and cuboid. Where the scaphoid and cuboid are in contact, there is a small cartilaginous articular facet which is lined either by a separate synovial membrane or by a process from the great tarsal synovial membrane; and where the external cuneiform touches the cuboid there is also a small cartilaginous articular facet.

Articulations of the two rows with each other.—There are three of these joints. That between the astragalus and scaphoid; that between the os calcis and scaphoid; and that between the os calcis and cuboid.

The joint between the astragalus and scaphoid, *the astragalo-scaphoid*, is an arthrodial one. There is usually only one ligament, the superior astragalo-scaphoid, which is a broad band passing obliquely from the neck of the astragalus to the upper surface of the scaphoid. It is thin and weak, and covered by the extensor tendons. The inferior calcaneo-scaphoid takes the place of an inferior ligament.

The external ligament of this joint when present may be seen on the dorsum, between the scaphoid and os calcis. If the tibialis posticus tendon be removed and some fibro-cartilaginous material cleaned away from it, the inferior calcaneo-scaphoid ligament will be seen in the sole of the foot.

The *synovial membrane* is part of that for the anterior calcaneo-astragaloid articulation. There is much mobility in this joint, but it is sufficiently feeble to allow of occasional dislocation of the astragalus.

Dissection.—Divide the superior astragalo-scaphoid ligament, and observe that the astragalus has two articular facets, a large one transversely elongated, and larger externally, for the scaphoid, and a smaller one below, for the os calcis. The scaphoid is hollow posteriorly, and is widest externally.

Movements.—The scaphoid moves down and in over the head of the astragalus, or in the opposite direction. When the scaphoid is pushed down, the external and upper ligaments are made tense, and when it is moved in the opposite direction the strong inferior calcaneo-scaphoid ligament is stretched.

Joint between the Os Calcis and Scaphoid.—The ligaments connecting these are two, viz. superior and inferior calcaneo-scaphoid.

The *superior or external calcaneo-scaphoid* is situated at the upper and outer side of the head of the astragalus, and acts as a lateral ligament to the astragalo-scaphoid articulation. It is narrower in the centre and is about three quarters of an inch deep, and arises with the internal calcaneo-cuboid or interosseous ligament, from the deep groove between the astragalus and the os calcis; and passes from the inner side of the anterior end of the os calcis to the outer side of the scaphoid. These two ligaments resemble the capital letter Y, being joined behind, but separate in front.

The *inferior or calcaneo-scaphoid* ligament is much the larger and stronger. It is a thick broad band, passing forwards and inwards from the anterior inferior extremity of the sustentaculum to a depression on the under surface of the scaphoid. It supports the head of the astragalus,

forming part of its articular cavity. Its under surface rests on the tibialis posticus tendon, and its upper is lined by the synovial membrane from the anterior calcaneo-astragaloid articulation.

The **articulation between the os calcis and the cuboid** has four ligaments, two dorsal and two plantar. The former are the superior calcaneo-cuboid and the internal calcaneo-cuboid or interosseous; the plantar are the long and short calcaneo-cuboid.

The *superior calcaneo-cuboid ligament* is a narrow thin fasciculus

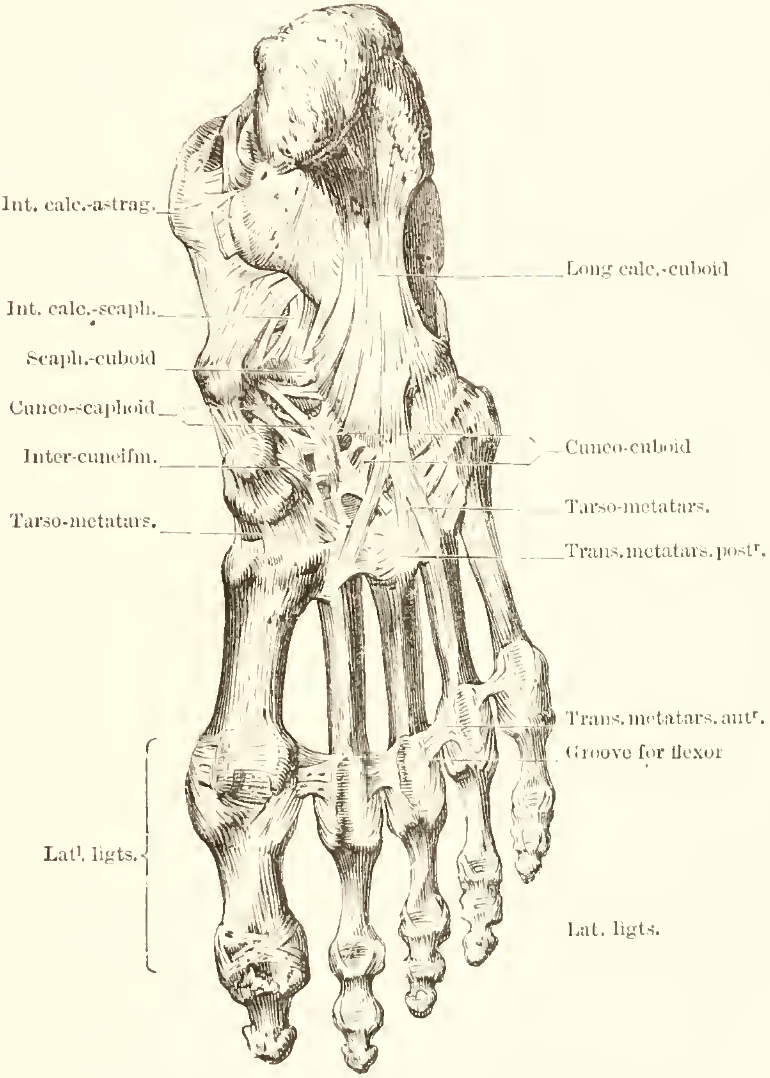


FIG. 150.—LIGAMENTS OF RIGHT FOOT. PLANTAR ASPECT.

between the contiguous surfaces of the os calcis and cuboid. On the dorsal aspect of the joint it may be situated at the outer border of the foot, and it is occasionally divided into two.

The *internal calcaneo-cuboid*, or *interosseous ligament*, is a strong, short, thick band, passing from the os calcis, in the groove between it and the astragalus, and closely blended at its origin with the superior calcaneo-scaphoid ligament to the cuboid. It is inserted into the inner side of the cuboid, and forms one of the main ligamentous bands between the first

and second row of bones. At its attachment to the os calcis it is external to the band for the scaphoid bone.

The *long calcaneo-cuboid* is the strongest of the ligaments of this joint, and is the more superficial of the two plantar ones. It is the longest of all the tarsal ligaments, and is called *ligamentum longum plantæ.* It is attached to the under surface of the os calcis very near the anterior and posterior tubercles, and is inserted in the ridge on the under surface of the cuboid, the innermost fibres passing over the tendon of the peroneus longus, aiding in the formation of its sheath, and its more superficial fibres pass to be inserted to the bases of the second, third, and fourth metatarsal bones.

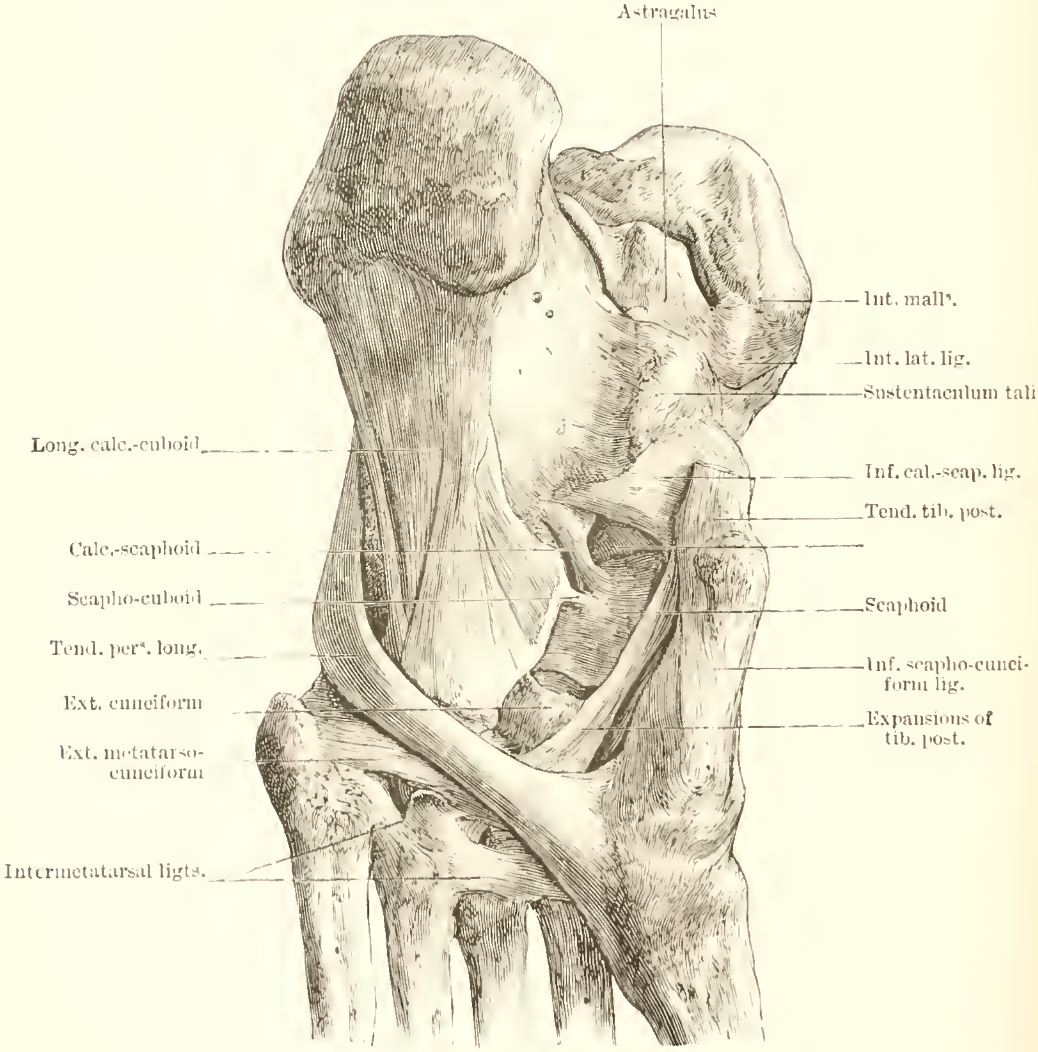


FIG. 151.—PLANTAR LIGAMENTS, POSTERIOR PART OF LEFT FOOT.

This ligament converts a groove on the under surface of the cuboid into a canal for the passage of the tendon of the peroneus longus.

The *short calcaneo-cuboid ligament* is the deeper plantar ligament, and will be seen after division of the superficial part, from which it is separated by a little adipose connective tissue. It is very broad, about an inch long, and passes from the tubercle, and the depression in front of it, to the fore part of the under surface of the os calcis and to the under

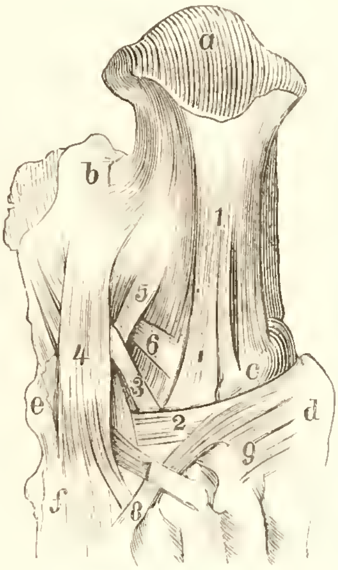
surface of the cuboid bone behind the peroneal groove, and internal to the ridge. A separate synovial membrane is found in this articulation.

Articular Surfaces.—At the *inner* side the os calcis is hollowed from above down, and the cuboid is convex; but both bones are flat towards the *outer* part of the articulation.

Movements.—The cuboid moves in all directions, obliquely down and in, or up and out. The internal lateral and the upper ligaments are rendered tense in the downward movement.

Transverse Tarsal Articulation.—The joints of the astragalus and scaphoid, and os calcis with the cuboid, form a transverse articulation in which the movements of inversion and eversion occur.

In *eversion* the inner border of the foot descends and lengthens, and the outer is raised, the great toe being abducted. The cuneiforms pass down, and the cuboid moves up and out on the os calcis; and the scaphoid moves in a similar direction over the head of the astragalus.



a. Os calcis.
b. Sustentaculum tali.
c. Cuboid.
d. Tuby. of fifth metars[l].
e. Cuneiform.
f. Base of first metars[l].
1. Long. calc.-cuboid.
2. Transverse calc.-cuboid.
3. Scapho-metatarsal.
4. Astragalo-metatarsal.
5. Calc.-scaphoid.
6. Transverse calc.-cuboid.
7. Cuneo-metatarsal.
8. Tarso- „
9. Inter- „

FIG. 452.—PLANTAR LIGAMENTS OF POSTERIOR PART OF RIGHT FOOT.

The plantar ligaments of both joints prevent excessive motion in this direction.

In *inversion* the inner border of the foot is shortened and raised from the ground, and the sole looks inwards; while the outer border is depressed and the great toe adducted. The scaphoid moves down and in over the astragalus, coming nearer to the internal malleolus; and the cuboid moves in a similar direction on the os calcis. The cuneiforms are at the same time raised and assist in the movement.

Dissection.—The student should examine the articulation of the head of the astragalus with the scaphoid, and of the os calcis with the cuboid; and then divide the ligaments to examine articulations of the cuneiform bones.

Besides the dorsal and plantar bands, which have already been mentioned, he must note some interosseous ligaments between the contiguous surfaces of the bones, and also some offsets of the common synovial

membrane. The articulation between the external cuneiform and cuboid is provided either with a distinct synovial sac, or with a prolongation of the common tarsal synovial membrane.

The synovial membrane of the cuneiform articulations is common to many of the tarsal bones. Situated between the cuneiforms and scaphoid, it sends a process forwards between the inner and middle cuneiform to between the second and third metatarsal bones. Another prolongation goes out, one to the joint between the scaphoid and cuboid, and occasionally a third to the articulation between the cuboid and external cuneiform.

Joint Surfaces.—There are three facets on the scaphoid; the two outer being flattened, the inner rounded. The cuneiforms join to form a shallow hollow which is elliptical and most excavated to its inner side.

Movements.—The cuneiforms move out and up on the scaphoid when the foot is inverted, and in eversion they glide down and in. The internal cuneiform moves more than the rest because of the shape of

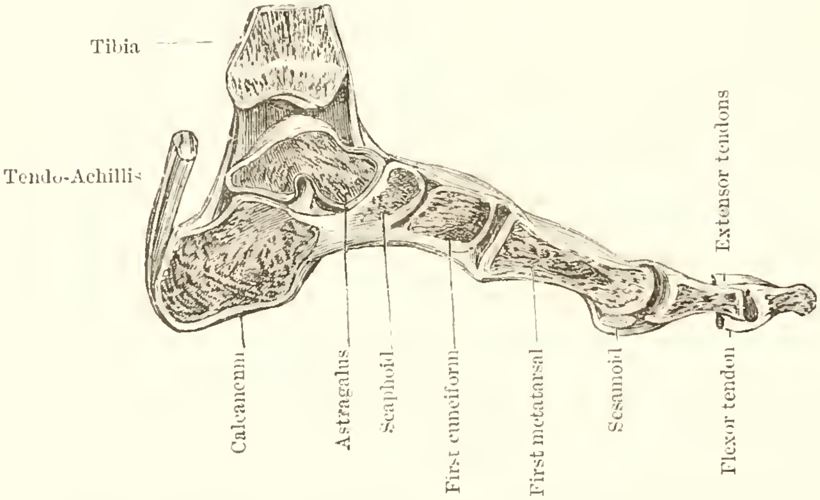


FIG. 153.—VERTICAL ANTERO-POSTERIOR SECTION OF THE FOOT THROUGH THE INNERMOST ROW OF BONES.

the articulating surfaces, and because the tibialis anticus is there attached. The dorsal ligaments are made tense when the bones are depressed, and as they rise they are kept together by the interosseous and transverse plantar bands. In walking and standing these bones are somewhat separated, and the pedal arch and transverse ligaments are stretched.

Articulation of the Metatarsal Bones with each other.—The bases of these bones, the first excepted, are joined by dorsal, plantar, and interosseous ligaments. The dorsal and plantar ligaments are small transverse bands which go from one metatarsal bone to the adjoining one. The interosseous ligaments are short transverse bands between the rough non-articular portions of their lateral surfaces. The articular surfaces are coated with cartilage and have processes of the synovial membrane from the tarsal and metatarsal joints. The distal extremities of the metatarsal bones are connected by the transverse metatarsal ligament. This ligament connects the great toe with the rest of the metatarsal bones,

differing in this respect from the transverse ligament in the hand. The metatarsal bone of the great toe resembles that of the thumb in not being joined to the others at its base by any connecting band. Sometimes a *ligamentum basium oss. metatarsi plantare longum* extends between the bases of the first and fifth toes, and contributes to the support of the pedal arch in a transverse direction.

Actions.—The movement in the tarsal ends of the metatarsal bones is only a slight gliding one, but considerable motion is allowed in their digital extremities.

Tarso-Metatarsal Joints.—These are arthrodial joints and resemble the similar parts in the hand, there being a separate joint for the great toe, and a common one for the four outer toes. The bones forming them are the cuboid, and the internal, middle, and external cuneiforms, which articulate with the five metatarsal bones.

Articulation of the Great Toe.—The first metatarsal is connected with the internal cuneiform by a dorsal and plantar longitudinal band, the latter being placed between a process of the tibialis anticus, and one from the peroneus longus. These ligaments are more or less continuous, forming a kind of capsule. A synovial membrane lines the joint. The articular surfaces are oval from above down, constricted in the middle and curved inwards. That of the great toe is hollow, and the other is convex.

Movements.—The metatarsal bone moves obliquely down and in, or up and out, resembling the motion of the external cuneiform with the scaphoid. This will help somewhat in eversion and inversion of the foot. There is also slight abduction and adduction at this joint.

Articulations of the Four outer Metatarsals.—The four outer metatarsals correspond to the three outer tarsal bones; the second metatarsal being wedged between the internal and external cuneiform and resting against the middle, which is the most strongly joined of all the metatarsal bones. The third metatarsal articulates with the external cuneiform; the fourth with the cuboid and external cuneiform; and the fifth with the cuboid. The joint surfaces are covered with cartilage and have a synovial membrane, and are attached to the bones with which they articulate by dorsal, plantar, and interosseous ligaments.

The *dorsal ligaments* are moderately strong flat fibrous bands, having a longitudinal direction from the tarsal to the metatarsal bones. Excepting the second toe, which has three, each metatarsal possesses one ligament. The third metatarsal has a ligament from the external cuneiform, and the fourth and fifth have one each from the cuboid. The three bands to the second come from all the cuneiforms,—one from each.

Plantar Ligaments.—These consist of oblique and longitudinal fibres disposed less regularly than on the dorsal surface. Those for the first and second metatarsal are most strongly marked. The second and third have strong bands which obliquely pass to them from the inner cuneiform; but the fourth and fifth have but a few fibres from the cuboid.

The *lateral ligaments* are longitudinal, deeply placed between the bones, and are placed between the second and third metatarsals. To see them the transverse bands must be cut. The metatarsal of the third toe has a lateral slip on its outer side attached above to the external cuneiform; that of the second toe has two bands, one on each side, the inner being

strong and attached to the internal cuneiform, and the outer is connected with the middle or the outer cuneiform.

There are usually some oblique plantar ligaments passing from the anterior aspect of the internal cuneiform to the second and third meta-

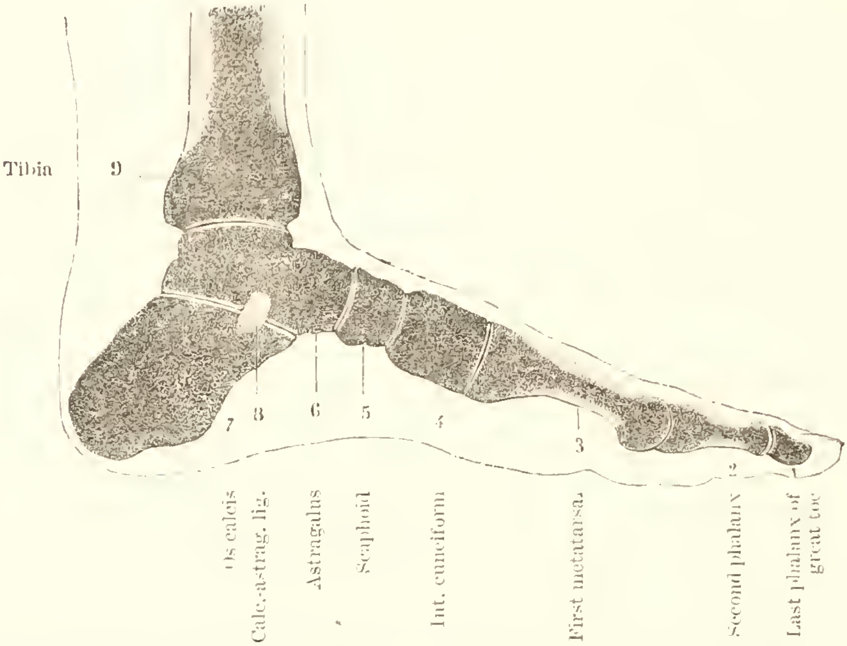
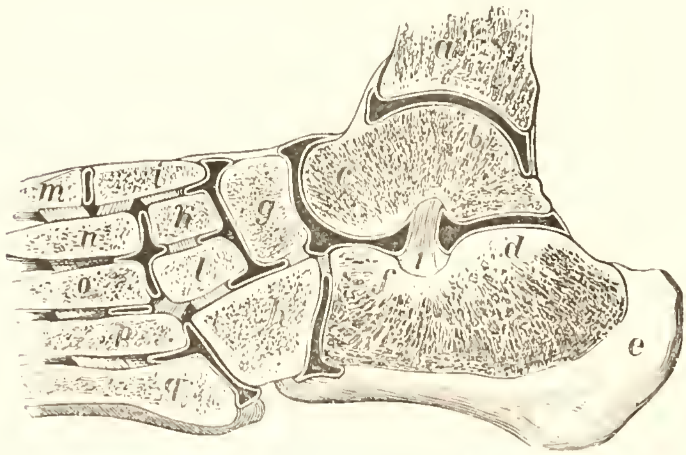


FIG. 454.—VERTICAL ANTERO-POSTERIOR SECTION TO SHOW THE FORMATION OF THE ARCH OF THE FOOT AND THE RELATION OF THE BONES TO THE SKIN.

tarsals; and from the external cuneiform there is also another slip to the fifth metatarsal and little toe.

Synovial Membrane.—There are three of these in these articulations,



a. Tibia.
b. Astragalus.
c. Its head.
d. Body.
e. Tubercle, and
f. Head of os calcis.
g. Scaphoid.
h. Cuboid.
i k l. Int. mid. and external cuneiform.
m n o p q. First, second, third, fourth, and fifth metatarsals.
1. Interosseous lig. The synovial cavities are shown.

FIG. 455.—OBLIQUE SECTION FROM WITHIN OUT OF THE LEFT TIBIA, TARSAL AND METATARSAL BONES. ONE-HALF. TO SHOW THE JOINT SURFACES AND SYNOVIAL CAVITIES.

one for the metatarsal of the great toe with the internal cuneiform; another for the middle and external cuneiform with the second and third metatarsal bones, this being a part of the great tarsal synovial membrane; the third is for the cuboid with the fourth and fifth metatarsals.

Articular Surfaces.—These are undulating, the tarsal bones being uneven to correspond to the wavy surfaces of the metatarsals.

Movements.—This is simply an up and down gliding, and is greatest in the little toe and the toe next it. The little toe has also an ab- and adductory motion, which to a very small extent exists in the fourth toe.

Metatarso-Phalangeal Joint.—In these articulations the head of the metatarsal bone is received into the hollow of the phalangeal cavity, forming ball-and-socket or condyloid joints. There are two lateral and an inferior ligament resembling those in the hand, the posterior ligament being formed by the expansion from the extensor tendons. A separate synovial membrane lines each joint. In the great toe joint there are two sesamoid bones which are connected with the lateral and inferior ligaments. These structures are more distinct in the hand, where their arrangement has been fully described.

Joint Surfaces.—The heads of the metatarsal bones are covered with cartilage, and are longest from above down, and reach further on the plantar surface. The base of the phalanx is provided with a cup-shaped cavity covered with cartilage.

Actions.—Movement in four directions with circumduction takes place in these joints. In flexion, which is more limited than in the hand, the phalanx passes under the head of the metatarsal bones, motion being limited by the contact of the bones, and by the extensor tendons and by

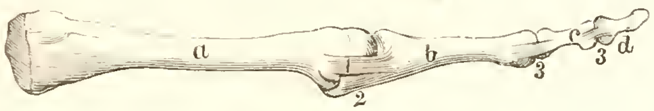


FIG. 456.—LIGAMENTS OF THE TOES. ONE-HALF.

a. Metacarpal bone. *b.* First phalanx. *c.* Second phalanx. *d.* Third phalanx. 1, 3, 3. Lateral ligt^s. 2. Fibro-cartilage.

the anterior and lateral ligaments. In extension, which is less limited than in the hand, the phalanx can be moved back beyond a straight line, the movement being limited by the inferior ligament, the flexor tendons, and the posterior parts of the lateral ligaments. Lateral movement, in which the phalanx passes from side to side on the head of its corresponding metatarsal, is limited by the lateral ligament of the side from which it is moved. Circumduction is not as unimpeded in the foot as in the hand, but is more free in the great toe joint.

Interphalangeal Articulation.—Each toe has two phalangeal joints, the first excepted. There are two lateral ligaments and an inferior or plantar. The joints between the last two phalanges are less well marked, and often the bones are anchylosed. A separate synovial membrane is present in each articulation. They resemble the corresponding ligaments in the hand.

Movements.—Flexion and extension only are permitted in these joints. In the former, which is more limited than in the hand, the distal phalanx passes under the proximal, and in extension, which is more pronounced than in the fingers, the two are brought into or beyond a straight line. Flexion is limited by the extensor tendon and the lateral ligament; and extension is checked by the flexor tendons and the plantar ligament.

The first phalanges are *flexed* by the interossei, lumbricales, flexor com-

munis digitorum, abductor hallucis, abductor minimi digiti, and flexor brevis hallucis. They are *extended* by the extensor communis digitorum, extensor proprius hallucis, and extensor brevis digitorum. The plantar interossei *adduct* and the dorsal interossei *abduct* them.

The second phalanges are *flexed* by the flexor brevis digitorum and flexor longus hallucis, and *extended* by the interossei, lumbricales, extensor brevis digitorum, extensor communis digitorum, and extensor proprius hallucis.

The third phalanges are *flexed* by the flexor communis digitorum, and

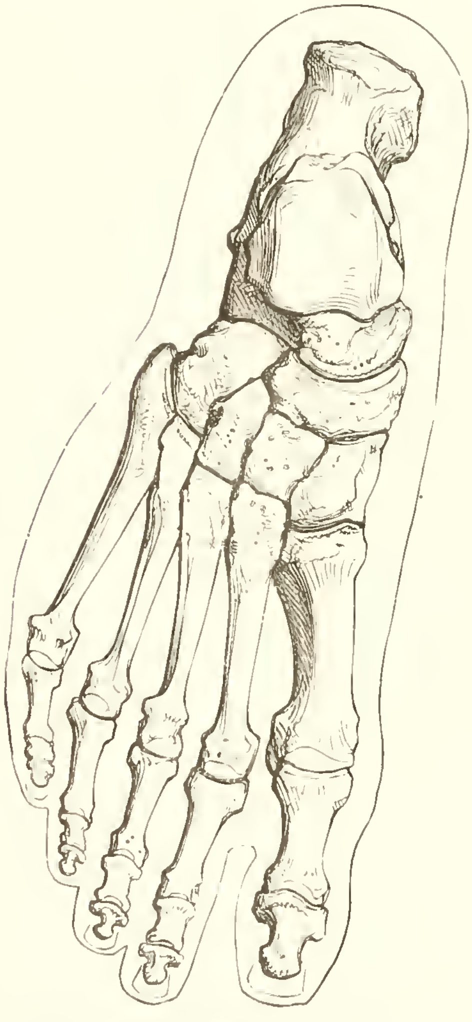


FIG. 457.—RIGHT MALE FOOT IN OUTLINE. TO SHOW THE RELATION OF THE BONES TO THE SKIN.

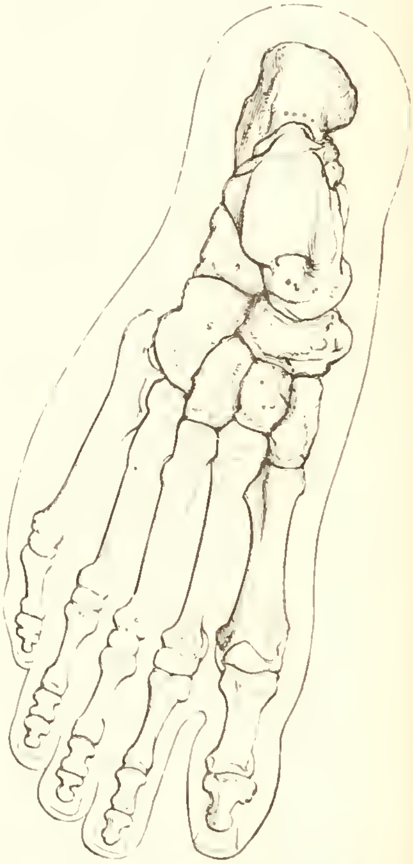


FIG. 458.—RIGHT FEMALE FOOT IN OUTLINE

extended by the interossei, lumbricales, and extensors longus and brevis digitorum.

Joint Surfaces.—In both phalangeal articulations the head of the phalanx presents a trochlear surface, and the base of the distal phalanx presents two lateral hollows separated by an intermediate ridge.

Directions.—The student should now remove the muscles from the femur, tibia, fibula, and foot, making himself first quite familiar with their attachments, and then should saw through the bones in various directions,

to examine their internal structure, which he will find given in the osteological part of his Systematic Anatomy, or in the Osteologies of Humphry, Holden, Ward, Wagstaffe, Norton, or Dwight. He should also saw through the articular ends, and observe the varying thickness of the articular cartilage, and if the subject be a young one he will note the epiphysial cartilages.

Muscles, Joints, &c. of Pelvic Gird

Name	Origin	Insertion	Action
Psoas	Transverse processes and sides of bodies of twelfth dorsal and first to third lumbar	Trochanter minor	Flexes the thigh o the trunk
Iliacus	Venter of ilium and ilio-lumbar ligament	,,	Flexes the thigh o the trunk
Tensor fasciæ latæ	Ilium ant. sup. spine	Fascia lata	Tenses the fascia an rotates the femur i wards
Sartorius	,, ,, and notch below it	Tibia just below int. tuberosity	Internal rotator an flexes thigh
Rectus	Ilium ant. inf. spine and depression above acetabulum	Patella	Extends the thigh
Vastus externus	Femur outer side and ext. lip of linea aspera and ext. mus. septum	Patella and knee capsule	.. ..
,, internus	Femur inner side, inner lip of linea aspera, and int. mus. septum	,, ,,	.. ..
Crureus	Ant. introch. line and front of femur	Patella	,, ..
Sub-crureus	Femur ant. surf., lower end	Synovial memb. of knee	,, ,,
Gracilis	Rami of pubes and ischium	Tibia below ant. tuberosity	Flex. and int. rota of leg
Pectineus	Pubes and ilio-pectineal line	Femur from lesser troch. to linea aspera	Adducts the thigh
Add. longus	Pubes below crest and from ramus	Middle third linea aspera	.. ..
,, brevis	Front of pubes	Linea aspera upper third and line to small trochanter	.. ..
Add. magnus	Pubes descending ramus, ischial ramus, and tuberosity	Femur and linea aspera to inner condyle	.. ,,
Obt. externus	Outer surface of obturator foramen and ant. half of memb.	Femur, dig. fossa	Ext. rotator of fem
Gluteus maximus	Ilium between crest and third line, sacrum, coccyx, and great sacro-sci. lig.	Fem. from troch. maj. to linea aspera and fas. lat.	Extends and rotates the thigh
,, medius	Ilium between superior and middle curved lines and deep fascia	Femur, to crest of great troch.	Extends and rotates the thigh
,, minimus	Ilium between middle and inferior lines	Femur, front of great troch.	Extends and rotates the thigh
Pyriformis	Front of sacrum	Femur, upper border of great troch. and dig. fossa	Ext. rotator of fem

and their Vascular and Nervous Supply.

Antagonists	Arteries come from	Veins go to	Nerves	Lymphatics go to
Glutei	Lumbar, ilio-lumbar and circumflex	Venæ comites	Lumbar plexus	Lumbar glands
,,	Lumbar, ilio-lumbar, circumflex, and cirflx. iliac	,,	,,	Inguinal and hypogastric glands
The pyriformis, gemelli, obturators, and quadratus femoris which are external rotators	Gluteal, sciatic, and external circumflex	,,	Superior gluteal	Inguinal and hypogastric glands
Biceps	Muscular of femoral, circumflex, and popliteal	Femoral, popliteal, and profunda	Anterior crural	Inguinal
Biceps, semitend., semimemb., soleus, and gastroc.	Muscular of femoral, circumflex, and popliteal	Femoral, popliteal, and profunda	,,	,,
Biceps, semitend., semimemb., soleus, and gastroc.	Muscular of femoral, circumflex, and popliteal	Femoral, popliteal, and profunda	,,	,,
Biceps, semitend., semimemb., soleus, and gastroc.	Muscular of femoral, circumflex, and popliteal	Femoral, popliteal, and profunda	,,	,,
Biceps, semitend., semimemb., soleus, and gastroc.	Muscular of femoral, circumflex, and popliteal	Femoral, popliteal, and profunda	,,	,,
Biceps, semitend., semimemb., soleus, and gastroc.	Muscular of femoral, circumflex, and popliteal	Femoral, popliteal, and profunda	,,	,,
Biceps and gluteus medius	Muscular of femoral and popliteal	Int. circumf., obturator femoral, and saphenous	Obturator	,,
Gluteus medius	Circumflex and obturator	Venæ comites	Ant. crural	,,
,,	Muscular of femoral, int. circumflx., obturator	,,	Obturator	,,
,,	Muscular of femoral, int. circumflx., obturator	,,	,,	,,
,,	Muscular of femoral, int. circumf., obturator	,,	,,	Inguinal glands
Tensor fasciæ and ant. part of glut. med.	Obturator, int. circumf., sciatic and int. pudic	,,	,,	Hypogastric glands
The psoas and iliacus	Sciatic and gluteal	,, and ext. circumf.	Inferior gluteal	Hypogastric glands
,, ,,	,, ,,	Venæ comites and ext. circumf.	Sup. gluteal	Hypogastric glands
,, ,,	,, ,,	Venæ comites and ext. circumf.	,,	Hypogastric glands
Tensor fasciæ and ant. part of gluteus medius	Gluteal, sciatic, and int. pudic	Venæ comites	Sacral plexus	Hypogastric glands

Muscles, Joints, &c. of Pelvic Girdle, and the

Name	Origin	Insertion	Action
Obturator internus	Inner margin of obturator foramen and memb.	Femur, upper border of great troch.	Ext. rotator of femur
Gemellus superior	Spine of ischium	To tendon of obt. int.	Ext. rotator
,, inferior	Tuberosity of ischium	,, ,,	,,
Quadratus femoris	,, ,,	Post. introch. line	,,
Biceps	Long head from tuber ischii, short head from outer lip of linea aspera	Fibula, outer side of head	Flexes the leg and slightly rotates it out
Semitendinosus	Tuberosity of ischium	Tibia below inner tuberosity	Flexes the thigh and slightly rotates it inwards
Semimembranosus	,, ,,	Back of int. tuber. of tibia; post. lig. of knee and expansion over popliteus	Flexes the thigh and slightly rotates it inwards
Gastrocnemius	Outer head, femur above outer condyle. Inner head, femur above inner condyle	Into tendo-Achillis and tuberosity of os calcis	Extends the foot
Plantaris	Above ext. condyle	Os calcis and post. lig. of ankle	Assists gastroc. and soleus, and renders tense the capsule
Soleus	Tibia, oblique line, and inner border. Fibula post. part of head, and upper third	Tub. calcanei through tendo-Achillis	Extends the foot
Popliteus	Femur, depression on outer condyle	Tib. above oblique line	Flexes the leg and slightly rotates it in
Flex. long. dig.	Tibia below oblique line and intoss. lig.	Grooves scaphoid, and bases of third phalanges of four lesser toes, plantar aspect	Flexes third phalange
Tibialis posticus	Tibia below oblique line, intoss. memb., fib. internal surface	Tuberosity of scaphoid and first and second cuneiform	Flexes, adducts, and raises inner border of foot
Flex. long. hall.	Fibula post. and ext. surface and intermuscular septa	Base of second phalanx of big toe	Flexes the second phalanx
Tib. anticus	Tibia, two-thirds of outer surface and ext. tuberosity; half of intoss. memb.; deep fascia	Int. cuneiform and base of first metatarsal	Raises inner border of foot
Extensor long. dig.	Tibia, outer half and tuberosity. Fibula anterior three-fourths; intoss. memb., deep fascia and septa	To the three phalanges of four outer toes	Extends these toes
Peron. tert.	Fibula, ant. fourth intoss. memb. and septum	Base of fifth metatarsal	Flexes the foot
Ext. prop. hall.	Fibula, ant. half, intoss. memb.	Base of second phalanx of great toe	Extends this phalan

ascular and Nervous Supply—*continued.*

Antagonists	Arteries come from	Veins go to	Nerves	Lymphatics go to
ensor fasciæ and ant. part of gluteus medius	Obturator, int. circumf. and sciatic	Venæ comites	Branch from sacral plexus	Hypogastric glands
ensor fasciæ and ant. part of gluteus medius	Sciatic and pudic	..	Branch from sacral plexus	Hypogastric glands
ensor fasciæ and ant. part of gluteus medius	.. ..	..	From branch to quadratus	Hypogastric glands
ensor fasciæ and ant. part of gluteus medius	Obt. and int. circumf.	..	Branch of sacral plexus	Hypogastric glands
uadriceps, sartorius, gracilis	Sciatic and perforating	,,	Great sciatic	Inguinal and hypogastric
uadriceps, biceps	Sciatic and perforating	..	,,	Inguinal and hypogastric
,, ..	Sciatic and perforating	,,	,,	Inguinal and hypogastric
ib. ant., peron. tert.	Sural and muscular of post. tibial	,,	Int. popliteal	Popliteal glands
—	External articular of knee	,,	,,	,,
b. ant. and peron. tert.	Sural and muscular of post. tib. and peroneal	,,	..	..
uadriceps	Articular of knee	,,	,,	,,
xt. com. dig.	Muscular of post. tib. and of peroneal	,,	Posterior tibial	..
b. anticus and peron. tert.	Post. tib. and peroneal	,,	,,	..
xt. hall. brev.	Post. tib. and peroneal	,,	,,	,,
oleus, gastroc., peron. long. and brev.	Ant. tib.	..	,,	Inguinal glands
ex. com. dig.	,,	,,	,,	,,
,,	..	,,		,,
ex. hall. long.	,,	,,	,,	..

Muscles, Joints, &c. of Pelvic Girdle, and the

Name	Origin	Insertion	Action
Ext. brev. dig.	Os calcis, calcaneo-astrag. lig. and ann. lig.	First phalanges of four inner toes	Extends the first phalanges of these toes
Peron. long.	Fibula, head and outer third; fascia and septa	Base of plantar aspect of first metatarsal and first cuneiform	Extends and abducts the foot, turning the sole outwards
„ brev.	Fibula, outer and lower third, and septa	Tubercle of fifth metatarsal	Extends and abducts the foot, turning the sole outwards
Flex. brev. dig.	Tuberosity os calcis	Plantar fascia and septa. Base of second phalanges of four lesser toes	Flexes these toes
Abd. hall.	Calcanean tuberosity and first cuneiform. Int. ann. lig. and fascia	Base of first phalanx of great toe and int. sesamoid	Draws the great toe inwards from the second
„ min. dig.	Outer tuberosity of os calcis, plantar fascia and septum, and tubercle of fifth metatarsal	Base of first phalanx of little toe on outer side	Draws the little toe away from the fourth
Flex. access.	By two heads from os calcis and from long plantar lig.	Tendon of flex. long. dig.	Separates flex. long dig. and bends the first phalanx of the four smaller toes
Lumbricales (four)	Tendons of flex. long. dig.	First phalanx of four smaller toes through expansion to extensors	Flexes the first phalanges
Flex. brev. hall.	Calcis, cuboid, and ext. cuneiform from tendon of tib. post.	Base of first phalanx of great toe and outer and inner sesamoids	Bends the first phalanx
Add. hall.	Second and third cuneiform, second, third, and fourth metatarsals and peroneal sheath	Outer side of base of first phalanx of great toe and ext. sesamoid	Adducts the great toe to the second
Flexor brev. min. dig.	Base of fifth metatarsal	Base of first phalanx of little toe	Flexes first phalanx of little toe
Transversus pedis	Transverse metatarsal lig.	Outer side of base of first phalanx of great toe	Adducts this toe to the second
Plantar interossei (three)	Between sides of third, fourth, and fifth metatarsals	Base of first phalanges of third, fourth, and fifth toes	Draw these toes towards the second
Dorsal interossei (four)	Adjacent sides of metatarsals	Base of first phalanges of second, third, and fourth toes	Separate the toes

ıscular and Nervous Supply—*continued.*

Antagonists	Arteries come from	Veins go to	Nerves	Lymphatics go to
'lex. com. and brev. dig.	Dorsal intoss.	Venæ comites	Posterior tibial	Inguinal glands
ib. ant. and peron. tert.	Peroneal	,,	Musculo-cutaneous	,,
ib. ant. and peron. tert.	,,	,,	,,	,,
xt. com. and brev. dig.	Ext. and int. plantar	,,	Int. plantar	,,
dd. hall.	Int. plantar	,,	,,	,,
lantar interossei	Ext. ,,	,,	Ext. plantar	,,
xt. com. and brev. dig.	Ext. and int. plantar	,,	,,	,,
xt. com. brev. dig.	,, ,,	,,	Two inner by int. plantar. Two outer by ext. plantar	,,
xt. hall. brev.	Int. plantar	,,	Int. plantar	,,
bd. hall.	,,	,,	Ext. ,,	,,
xt. com. and brev. dig.	Ext. and int. plantar	,,	,,	,,
bd. hall.	Plantars	,,	,,	,,
orsal interossei	Plantar arch	,,	,,	Popliteal glands
antar ,,	Dorsal interossei	,,	..	,,

Summary of all Important Facts connected with the Bones of the Pelvic Girdle.

O = Origin. I = Insertion.

Name of bone	Ligaments attached	Place of attachment	Muscles attached	Place of attachment	Bones they articulate with	Ossific centres and date of appearance
Ilium	Ilio-lumbar	To postero-inner part of crest	External oblique	o. Outer lip of crest	The sacrum and femur, and it unites with the ischium and pubes	One primary and two secondary. The primary appears about the eighth week just above the sciatic notch: the secondary one is for the crest and anterior inferior spine, and appears from the fifteenth to twentieth years. From the twelfth to the fourteenth year it joins the ischium through the ossifying Y-shaped cartilage in the acetabulum
	Anterior sacro-iliac	Antero-internal surface	Internal ,,	o. Middle ..		
	Posterior ,,	Postero-internal surface, and posterior superior spine	Transversalis abdominis	o. Inner ,,		
	Lumbo-sacral	Antero-inner surface	Gluteus maximus	o. Dorsum ilii		
	Ilio-femoral	Ant. inf. spine				
	Capsular	Upper margin of acetabulum	,, medius			
	Great sacro-sciatic	Above great sacro-sciatic foramen	,, minimus			
	Cartilage	On auricular surface	Iliacus	o. Venter ilii		
	Cotyloid	Margin of acetabulum	Sartorius	o. Anterior superior spine		
			Tensor fasciæ-latæ			
			Rectus femoris	o. Anterior inferior spine		
			Latissimus dorsi	o. Posterior part of crest		
			Quadratus lumborum			
Ischium	Great sacro-sciatic	Posterior surface of tuber	Coccygeus	o. Spine of ischium	One. The femur, and unites with the ilium and pubes	One primary centre for the body which appears about the third month. The ramus is completely ossified about the sixth year. One secondary for the tuberosity appears between the fifteenth and twentieth years, which unites with the body about the twenty-fifth year
	Lesser ,,	To spine	Gemellus superior	I.		
	Obturator membrane	Round margin of obturator foramen	,, inferior	I.		
	Capsular	Round lower margin of acetabulum	Quadratus femoris	o.		
	Cotyloid	Margin of acetabulum	Semitendinosus	o. Tuber		
	Transverse	Margins of acetabular notch	Semimembranosus	o.		
	Ligamentum teres	Ischial edge of acetabular notch	Biceps, long head	o.		

	Lesser sacro-sciatic	Spine	Transversus peronei	o.		
			Adductor magnus	o.		
			Ischio-cavernosus	o. Ascending ramus		
			Deep transverse	o.		
			Obturator ext. and int.	o. Round obturator foramen		
			Levator ani	o. Internal surface		
Pubes	Anterior pubic	Front of symphysis	Pectineus	o. Ilio-pectineal line	Two. The opposite innominate and femur	One primary and one secondary. The former appears between the fourth and fifth months, and is for the body; the latter appears from the fifteenth to the twentieth years, and is for the symphysis. The centre for Y-shaped piece at the bottom of the acetabulum appears from the sixth to tenth year, and unites the three portions of the innominate bone, and it is completely ossified from the twelfth to the fourteenth year
	Posterior ,,	Back ,,	Adductor longus			
	Superior ,,	Upper surface of symphysis	,, brevis	o. Descending ramus		
	Sub-pubic	Lower surface of symphysis	,, magnus			
	Fibro-cartilage	Between bones	Gracilis	o.		
	Capsular	Inner margin of acetabulum	Rectus abdominis	o. Horizontal ramus		
	Cotyloid	Margin of acetabulum	Levator ani	o. Descending ,,		
	Transverse	Margin of acetabular notch	,, urethræ	o. Symphysis		
	Ligamentum teres	Pubic edge of acetabular notch	Pyramidalis			
	Pubo-femoral	Antero-inferior surface	Ischio-cavernosus	o. Descending ramus		
Femur	Capsular	Neck	Gluteus medius		With three bones. Os innominatum, tibia, and fibula	By five centres. One for the shaft at the fifth week, one for each condyle and tuberosity at the ninth month, one for the head at the twelfth month, one for the great trochanter at the fourth year, and one for the lesser trochanter about the fourteenth year. The epiphyses join the shaft in the reverse order of their appearance.
	Ilio-femoral	Introchanteric line	,, minimus			
	Pubo-femoral	Inf. surface of neck				
	Lig. teres	Pit of head of femur	Pyriformis	I. Great trochanter		
	,, capsular of knee	Around the lower end above condyles	Gemelli			
	,, mucosum	Intercondyloid fossa	Obturators			
	,, alaria	Sides of patella				
	,, external lateral	External tuberosity	Quadratus femoris	I. Great troch. and post. introchanteric line		
	,, internal ,,	Internal ,,	Crureus	o. Anterior introch. line		

Summary of all Important Facts connected with the Bones of the Pelvic Girdle—*continued.*

O = Origin. I Insertion.

Name of bone	Ligaments attached	Place of attachment	Muscles attached	Place of attachment	Bones they articulate with	Ossific centres and date of appearance
Femur *cont.*	Anterior crucial	Inner surface of ext. cond.	Iliacus	I. Lesser trochanter		The union takes place after puberty, the small trochanter being joined about the eighteenth year; the greater a little after this: the head a little after the great trochanter: and lastly, the lower epiphysis joins about the twentieth year
	Posterior ..	Inner surface of int. cond.	Psoas			
			Pectineus	I. Line from great trochanter to linea aspera		
			Gluteus maximus	I.		
			Three adductors	O.		
			Vastus ext. and int.	O.		
			Biceps, short head			
			Popliteus	O. Ext. condyle		
			Plantaris			
			Gastrocnemius	O. Ext. and int. condyle		
			Subcrureus	O. Front of lower end of shaft		
Patella	Capsular of knee	Around borders	Quadriceps femoris	Superior margin	With condyles of femur	One centre, appearing about the third year. It is sometimes cartilaginous at the age of six, and very rarely is developed by two centres situated beside each other. It is completely ossified between the fifteenth and twentieth years
	External alar	Outer edge				
	Internal ..	Inner ..				
	Lig. patellæ	Apex				
	,, alaria	Sides				
	Capsular of knee	Margins of head	Quadriceps femoris	I. To tubercle	With three bones, Femur, tibula in two places, and astragalus	By three centres. One for the shaft from the fifth to the eighth week: one for the upper end about the ninth month: one for the lower end in the second year. The last to appear is the first to join, and union takes place about the twentieth year.
	Semilunar cartilages	Upper surface and to spine	Sartorius	I. Below internal tuberosity		
	Coronary	Margin of tibia				
	Transverse of knee	Between fibro-cartilages	Gracilis			
	Anterior crucial	Inner side of front of spine	Semitendinosus			
	Posterior ,,	Behind the spine	Semimembranosus	I. Back of internal		

		behind				extraossific centres, one for the tubercle and one for the internal malleolus
Tibia	Lig. patellæ	To tubercle	Extensor com. dig.	o. External surface		
	Interosseous	To the crest	Flexor ,,	o. Internal surface		
	Ant. inf. tibio-fibular	Outer side of lower end of shaft	Tibialis posticus	o. Posterior ,,		
	Post. ..	Back of lower end of shaft				
	Ant. of ankle	Anterior margin of lower end				
	Post. ,,	Posterior margin of lower end				
	Internal lateral	Apex of internal malleolus				
	Inferior interosseous	Outer side lower end				
	Transverse of ankle	Posterior part of int. mall.				
Fibula	External lateral of knee	Apex of head	Biceps	1. Head	With two bones. The tibia above and below, and the astragalus	By three centres. One for the shaft from the sixth, eighth, or ninth week, a little later than the tibia. The centre for the lower epiphysis appears about the second year, and in the upper one about the fourth. This bone offers an exception to the law of union of epiphyses with the shaft, as it is the first in which ossification begins, and also becomes first united to the shaft, which occurs about the twentieth year; the upper one joining about the twenty-fifth. In all long bones the epiphysis towards which the nutrient artery is directed is the first joined to the shaft
	Ant. sup. tibio-fibular	Front ..	Peroneus longus	o. Outer surface, upper part		
	Post. sup. tibio-fibular	Back ..	,, brevis	o. Outer surface, middle part		
	Interosseous	Inner margin	,, tert.	o. Inner surface, lower part		
	Ant. inf. tib. fib.	Anterior surface, lower end	Ext. hall. long.	o. Inner surface, upper part		
	Post. ,,	Posterior surface, lower end	Flex. ,,	o. Posterior surface, upper part		
	External lateral of ankle	Apex ext. mall.				
	Inferior interosseous	Inner surface, lower end				
	Transverse of ankle	Back of external malleolus				

Tarsal and Metatarsal Bones and Phalanges.

O = ORIGIN. I = INSERTION.

Name of bone	Ligaments attached	Place of their attachment	Muscles attached	Place of their attachment	Bones they articulate with	Ossific centres and date of appearance
Astragalus	Anterior of ankle	Anterior margin			With four bones: the tibia, fibula, os calcis and scaphoid	By one centre, which appears about the seventh month
	Internal lateral, posterior fibres	Inner side				
	Ext. lateral anterior fasciculus	Front of ext. facet				
	Ext. lateral posterior fasciculus	Behind ,, ,,	Flex. hall. long.	In its groove		
	Ext. calc.-astragaloid	Outer surface				
	Post. ,,	Posterior surface				
	Interosseous	Groove				
	Astragalo-scaphoid	Neck, upper surface				
Os calcis	Int. lateral, middle fibres	Inner surface	Gastrocnemius Soleus Plantaris	I. Tuberosity	With two: the astragalus and cuboid	By two centres; that for the body appears about the sixth month, and that for the tuberosity about the tenth year, and unites soon after puberty
	Ext. lateral, middle fasciculus	Outer ,,	Flex. brev. dig. Abd. hall. ,, min. dig.	O. ,,		
	Ext. calc.-astragaloid	,, edge	Flex. access. Opp. min. dig.	O. Plantar surface		
	Post. ,,	Post. surface	Extensor brev. dig.	Dorsal and lateral surface		
	Interosseous	Groove				
	Sup. calc.-cuboid } dorsal	Dorsal surface				
	Int. calc.-cuboid } dorsal	Groove				
	Long calc.-cuboid } plantar	Plantar surface near tuberosity				
	Short calc.-cuboid } plantar	Plantar surface forepart				
	Sup. calc.-scaphoid	Groove				
	Inf. ,,	Ant. inf. surface				
Scaphoid	Int. lateral, ant. fibres	Inner surface				
	Dorsal } tarsal Plantar } tarsal Interosseous } tarsal	Corresponding surfaces	Abd. hall. Tib. posticus	O. Dorsal surface I. Tuberosity. Its tendon also rests in the groove	With four bones: astragalus and three cuneiform, and occasionally with the cuboid	By one centre, which appears in the fourth year

Cuboid	Sup. calc.-cuboid, Int. calc.-cuboid } dorsal	Upper surface Inner ,,	Tibialis posticus Peroneus long. Flex. access .. brev. hall. Add. hall. Flex. brev. min. dig.	I. Plantar surface In its groove o. Plantar surface	With four bones; the calcis, external cuneiform, and fourth and fifth metatarsals. Sometimes with the scaphoid	By one centre, which appears about the ninth month
	Long calc.-cuboid, Short calc.-cuboid } plantar	Ridge on under surface Inferior surface				
	Dorsal, Plantar, Interosseous } Tarsal and tarso-metatarsal	Corresponding surfaces				
Internal Cuneiform	Dorsal, Plantar, Interosseous } Tarsal and tarso-metatarsal	Corresponding surfaces	Abd. hall. First dorsal intoss. Tib. ant. ,, post. Peroneus long.	o. Inner surface o. Dorsal ,, I. Inner ,, I. Lower ,, I. ,, ,,	With four bones: the scaphoid, middle cuneiform, and first and second metatarsals	By one centre, which appears about the third year
Middle Cuneiform	Dorsal, Plantar, Interosseous } Tarsal and tarso-metatarsal	Corresponding surfaces	Flex. hall. brev. Tib. post.	o. Plantar .. I.	With four bones: scaphoid, int. and ext. cuneiform, and second metatarsal	By one centre, which appears about the fourth year
External Cuneiform	Dorsal, Plantar, Interosseous } Tarsal and tarso-metatarsal	Corresponding surfaces	Flex. hall. brev. Add. hall. Tib. post.	o. o. Plantar .. I.	With six bones: the scaphoid, middle cuneiform, cuboid, and second, third, and fourth metatarsals	By one centre, which appears during the first year
Metatarsal Bones			Peroneus long. Tib. ant. Flex. hall. brev. Abd. hall.	I. Base of first metatarsal I. Partly to first metatarsal o. Partly to under surface o. Under surface of base	The first metatarsal articulates with three: the internal cuneiform, the second metatarsal and first phalanx.	The metatarsals are each developed by two centres: one for the shaft and one for the head in the four outer, one for the base in the metatarsal of the great toe
	Dorsal, Plantar, Interosseous } Inter-metatarsal	Corresponding surfaces	Add. hall.	o. Bases of third and fourth	The second metatarsal articulates with six: the three cuneiform, first and third metatarsals, and first phalanx	Ossification begins in the centre of the shaft about the seventh week, and in the epiphyses about the third year.
	Plantar, Ext. and int. lateral } Metatarso-phalangeal	Corresponding surfaces	Abd. min. dig. Peron. brev.	o. Tuberosity of fifth I. Tuberosity of fifth	The third metatarsal articulates with	

Tarsal and Metatarsal Bones and Phalanges—*continued.*

O = ORIGIN. I = INSERTION.

Name of bone	Ligaments attached	Places of their attachment	Muscles attached	Place of their attachment	Bones they articulate with	Ossific centres and date of appearance
Metatarsal Bones *cont.*			Peron. tert. Flex. brev. min. dig. Dorsal interossei Plantar ,, Transversus pedis	I. Base of fifth O. .. O. Lateral surface O. .. O. Heads of fourth and fifth plantar surface	four: the external cuneiform, the second and fourth metatarsals, and first phalanx The fourth articulates with five: the cuboid and external cuneiform, the third and fifth metatarsals, and first phalanx The fifth articulates with three: the cuboid, fourth, metatarsal, and first phalanx	and they join the shaft between the eighteenth and twentieth years
			Ext. brev. dig. Flex. brev. hall. Ext. long. hall. Flex. ,, Add. hall.	I. Dorsal surface of base of first phalanx, four inner I. Plantar surface of base of phalanx of great toe I. Dorsal surface of second phalanx of great toe I. Plantar surface of second phalanx of great toe I. External sesamoid of great toe	The phalanges articulate with each other, and with their corresponding metatarsals	They are developed by two centres for each bone: one for the shaft and one for the base. The former appears from the second to the fourth month The epiphyses of the second phalanges appear about the fourth year, and that of the second and third phalanges

				Abd. ,,	I. Internal sesamoid of great toe		from the sixth to the seventh year, and they become united to the shaft from the sixteenth to the eighteenth year
Phalanges	Plantar Ext. and in. lateral	Metatarso-phalangeal	Corresponding surfaces	Ext. com. dig.	I. Bases of second and third phalanges of four outer toes, dorsal surface		
	Plantar Ext. and int. lateral	Inter-phalangeal	Corresponding surfaces	Flex. ..	I. Bases of three phalanges of four outer toes, plantar surface		
				Flex. brev. min. dig.	I. Plantar surface of base of first phalanx of little toe		
				Abd. ..	I. Outer surface of base of first phalanx of little toe		
				Lumbricales	I. Inner surface of base of four outer toes.		
				Plantar interossei	I. Inner surface of base of three outer toes		
				Dorsal	I. Outer side of bases of second, third, and fourth toes, and inner side of base of second toe		

TABULAR SUMMARY OR SYNOPSIS OF THE ARTERIES OF THE LOWER LIMB.

The femoral artery is the continuation of the external iliac, and gives off the

- Superior external pudic.
- Superficial epigastric.
- Superficial external circumflex.
- Inferior external pudic.
- Profunda, which gives off the
  - External circumflex, which gives off
    - Ascending.
    - Transverse.
    - Descending.
  - Internal circumflex, which gives off
    - Muscular.
    - Articular to hip.
    - Ascending.
    - Transverse.
  - First perforating.
  - Second perforating gives off
    - Nutrient to femur.
  - Third perforating.
  - Terminal.
- Muscular.
- Anastomotica magna gives off
  - Superficial.
  - Deep.
- Popliteal, which gives off
  - Muscular.
  - Superior internal articular.
  - „ external „
  - Inferior „ „
  - „ internal „
  - Azygos articular.
  - Sural.
  - Anterior tibial, which gives off
    - Recurrent.
    - Cutaneous.
    - Muscular.
    - External malleolar.
    - Internal „
    - Articular.
    - Tarsal.
    - Metatarsal, gives off
      - Three interosseous.
    - First interosseous.
    - Communicating to deep arch.
    - Digital = —Great toe and half the next.
  - Posterior tibial, which gives off
    - Peroneal, which gives off
      - Muscular.
      - Nutrient to fibula.
      - Anterior peroneal.
    - Nutrient to tibia.
    - Communicating to peroneal.
    - Articular to ankle.
    - Internal plantar.
    - External plantar, which gives off
      - Muscular.
      - Plantar arch, which gives off
        - Muscular.
        - Posterior perforating.
        - Digital for three and a half outer toes.
        - Anterior perforating.

N.B.—The obturator, sciatic, and gluteal arteries will be given with the arteries of the pelvis.

TABULAR SUMMARY OR SYNOPSIS OF THE VEINS OF THE LOWER LIMB (ELLIS, MODIFIED).

The femoral vein is the continuation of the popliteal, and continues into the external iliac, and receives the

- Popliteal receives
  - Posterior tibial receives
    - External plantar receives
      - Muscular.
      - Plantar arch receives
        - Posterior perforating.
        - Digital for three and a half outer toes.
        - Anterior perforating.
    - Internal plantar.
    - Articular.
    - Communicating to saphenous.
    - Nutrient.
    - Peroneal receives
      - Anterior peroneal.
      - Muscular.
      - Nutrient.
  - Anterior tibial receives
    - Communicating to deep arch receives
      - Digital from great toe and half the next.
    - Metatarsal receives
      - Three interosseous.
    - Tarsal.
    - Malleolar.
    - Communicating to saphenous.
    - Muscular.
    - Recurrent.
  - External saphenous receives
    - Branch from dorsal arch of foot.
    - Plantar (external).
    - Veins from outer side of heel.
    - Cutaneous of leg.
  - Sural.
  - Articular.
  - Muscular.
- Anastomotic receives
  - Superficial branch.
  - Deep "
- Muscular.
- Profunda receives
  - Terminal.
  - First perforating.
  - Second perforating receives
    - Nutrient.
  - Third perforating.
  - External circumflex receives
    - Ascending.
    - Transverse.
    - Descending.
  - Internal circumflex
    - Muscular.
    - Articular.
- Internal saphenous receives
  - Branch from dorsal arch of the foot.
  - Plantar (internal).
  - Veins around os calcis.
  - Communicates with anterior and posterior tibial.
  - Communicates with deep veins of thigh.
  - Cutaneous from outer and inner parts of thigh.
  - External pudic.
  - Superficial epigastric.
  - Superficial circumflex iliac.

Anastomoses of Lower Limb.

Region	Anastomosing Arteries
Gluteal	The posterior branches of fourth and fifth lumbar from abdominal aorta and posterior branches of lateral sacral of internal iliac with external circumflex from profunda femoris and with gluteal from internal iliac. The sciatic from internal iliac with internal circumflex from profunda. The gluteal with circumflex iliac of external iliac and external circumflex from profunda.
Thigh. Inosculations about the hip joint. In thigh proper	The superficial epigastric of femoral, with the deep from external iliac and with internal mammary of subclavian. The superficial circumflex iliac of femoral with the deep from external iliac, and with the gluteal from internal iliac, also with external circumflex of profunda. Superficial external pudic of femoral with perineal branches from internal pudic and the deep external pudic joins smaller branches of the last-named artery. The external circumflex by its ascending branches joins the gluteal of internal iliac and circumflex iliac from the external. The transverse branches of profunda unite with the internal circumflex and superior perforating from the same source and with the sciatic from internal iliac. The descending branches of the profunda anastomose with the superior articular of popliteal. The internal circumflex of profunda anastomoses with the obturator from internal iliac and with the external circumflex and superior perforating of profunda, and with the sciatic from internal iliac. The perforating of profunda are three, of which the first joins the second and internal circumflex, also the sciatic. The second unites with the first and third perforating. The third unites with the second and with the terminal branches of the profunda. The anastomotica magna of femoral joins with the superior internal and external articular of popliteal and recurrent of anterior tibial.
Around knee joint	The superior articular of the popliteal anastomoses with the inferior perforating and terminal of profunda. The superior internal articular anastomoses with the anastomotica magna and inferior internal articular and superior external articular. The superior external articular anastomoses with the anastomotica magna and descending branch of external circumflex. The inferior internal articular anastomoses with the tibial recurrent, inferior external articular and superior external articular. The inferior external articular joins the inferior internal and superior external articular and recurrent tibial.
Leg	The recurrent of anterior tibial anastomoses with the inferior articular of popliteal, and the muscular branches of the same vessel join branches of the posterior tibial and peroneal. The peroneal anastomoses with the external malleolar, tarsal, external plantar, and internal calcanean. The anterior peroneal inosculates with the external malleolar and tarsal. The communicating of posterior tibial joins the peroneal. The calcanean unites with the peroneal and internal malleolar. The external plantar joins the communicating from the dorsalis pedis, and by its posterior perforating branches anastomoses with the interosseous from the metatarsal. The digital branches of the plantar arch anastomose with the dorsal digitals from the interosseous arteries.
About ankle	The internal malleolar unites with the posterior tibial, dorsalis pedis, and internal plantar, the external anastomoses with the anterior peroneal and tarsal.
Metatarsals	The tarsal of dorsalis pedis joins the peroneal, external malleolar, external plantar, and metatarsal. The metatarsal unites with the tarsal, external plantar, posterior perforating from plantar arch, and anterior perforating from the digital. The communicating joins the external plantar to form the plantar arch.
Phalanges	The dorsal digital branches of the interosseous anastomose with each other and with the plantar digitals.

Synovial Sheaths of Tendons and Muscular Bursæ of Lower Limb.

Around Hip.

1. Beneath tendon of psoas (sometimes communicates with joint).
2. ,, ,, gluteus medius.
3. ,, ,, obturator internus.
4. Between ,, gluteus maximus and vastus externus.
5. Over tuber ischii.

Around Knee.

1. Under tendon of biceps.
2. ,, ,, semimembranosus (sometimes enters joint).
3. ,, ,, popliteus (sometimes enters joint).
4. Around ,, semitendinosus.
5. Between ,, semimembranosus and inner head of gastrocnemius.
6. ,, ,, inner hamstrings and the tibia.
7. Beneath insertion of ligamentum patellæ.

Around Ankle.

1. Along tendon of tibialis anticus.
2. ,, ,, extensor longus hallucis.[1]
3. ,, ,, ,, communis digitorum.[1]
4. ,, ,, tibialis posticus.[1]
5. ,, ,, flexor longus digitorum.[1]
6. ,, ,, ,, ,, hallucis.[1]
7. ,, ,, peroneus longus.[1]
8. ,, ,, ,, brevis.

In Foot.

1. Between tendo-Achillis and os calcis.
2. Around tendon of peroneus longus, on external surface of os calcis.
3. ,, ,, ,, brevis ,, ,, ,,
4. ,, ,, ,, longus, in cuboid groove.
5. ,, ,, flexor longus digitorum.
6. ,, ,, ,, brevis ,,
7. ,, ,, extensors longus and brevis digitorum.

Subcutaneous Bursæ which are Normal and Constant.

In Lower Limb.

1. Over anterior superior iliac spine.
2. ,, great trochanter.
3. In front of patella, between it and quadriceps tendon.
4. Over lower half of patella, between the skin and tendon.
5. ,, superior and external angle of the patella.
6. ,, external tuberosity of femoral condyles.
7. ,, internal ,, ,, ,,
8. ,, external tibial tuberosity.
9. ,, internal ,, ,,
10. ,, tubercle of tibia between skin and ligamentum patellæ.
11. ,, some part of tibial crest.
12. ,, head of fibula (outer side usually).
13. ,, internal malleolus.
14. ,, external ,,
15. ,, postero-inferior surface of calcaneum between skin and fat.
16. ,, plantar surface of head of fifth metatarsal.
17. ,, ,, ,, ,, first ,,
18. ,, dorsal ,, interphalangeal joints.

[1] In very rare instances one or other of these may communicate with the ankle joint.

Bursæ which are Normal but Inconstant.

1. On external aspect of thigh, about its middle.
2. „ anterior „ „ „
3. „ dorsal „ scaphoid.
4. „ tubercle of scaphoid.
5. „ tarsometatarsal joint.
6. „ inner surface of head of first metatarsal.
7. „ posterior extremity of fifth „
8. „ external surface of anterior extremity of fifth metatarsal.

Tabular Summary or Synopsis of the Nerves of the Lower Limb.

Branches of the lumbar plexus.

- 1. External cutaneous from second and third divides into — Anterior and posterior branches, which supply outer side of hip and thigh.
- 2. Obturator from third and fourth divides into
  - Accessory from obturator or third and fourth, and gives off
    - To anterior division of obturator.
    - To pectineus.
    - Articular to hip.
  - Superficial division gives off
    - Muscular supply
      - Gracilis.
      - Adductor longus.
    - To mid-femoral plexus.
  - Deep division supplies
    - Adductors brevis and magnus.
    - Articular to knee.
    - To obturator externus.
    - To hip.
- 3. Anterior crural from second, third, and fourth, and divides into
  - Superficial part
    - Muscular supplies
      - Sartorius.
      - Pectineus.
    - Middle cutaneous.
    - Internal cutaneous — Anterior and internal branches.
  - Deep part
    - Muscular, supply
      - Rectus.
      - Vastus externus and knee.
      - Vastus internus, crureus, and knee.
    - Internal saphenous gives off branches — To patellar plexus, and to leg and foot.
- 4. Crural branch of genito-crural from first and second — To skin of upper part of thigh joining the middle cutaneous.

Branches of the sacral plexus.

- 1. Small sciatic from third and fourth, gives off
  - Inferior gluteal to gluteus maximus.
  - Inferior pudendal to skin of perinæum, scrotum, &c.
  - Cutaneous to gluteal region, thigh, and leg.
- 2. Great sciatic is continuation of the plexus and gives off
  - Articular to hip.
  - To hamstring muscles.
  - External popliteal or peroneal, and gives off
    - Articular to knee.
    - Cutaneous.
    - Communicans peronei.
    - Recurrent articular to knee.
    - External or musculo-cutaneous
      - To peronei.
      - Cutaneous to foot and toes.
    - Anterior tibial
      - Muscular to front of leg.
      - Articular to ankle.
      - Cutaneous to adjoining sides of great and second toes.
  - Internal popliteal, which gives off
    - Articular to knee.
    - Muscular.
    - Short saphenous,
    - Posterio tibial
      - Muscular to flexors.
      - Internal plantar which gives off
        - Cutaneous to sole.
        - Muscular.
        - Four digital.
        - Communicating.
        - Articular to toes.
      - External plantar gives off
        - Superficial
          - Muscular.
          - Two digital.
          - Articular.
        - Deep
          - Muscular.
          - Articular.
- 3. To gluteus maximus.
- 4. To quadratus femoris and gemelli, which give off articular to hip.
- 5. Superior gluteal, which supplies the gluteus medius and minimus and tensor fasciæ latæ, and comes from lumbo-sacral cord.
- 6. Muscular to
  - Pyriformis gemelli.
  - Obturator internus and levator ani.

CHAPTER VI.

HOMOLOGIES OF THE LIMBS.

THE LIMB BONES.

The student, having now dissected the upper and lower limbs, should be in a position to understand the homologous parts of the respective thoracic and abdominal or pelvic members, and at the same time to compare and contrast them.

The number of bones in the skeleton varies at different ages of life; some bones, which are originally made up of two, three, or more parts, becoming united as ossification proceeds; but in the adult, aged from 25 to 30, there are thirty-two bones in each upper limb, making sixty-four for the two; each lower limb has one less, making sixty-two for both lower extremities, and this is due to there being no bony structure to correspond exactly with the clavicle. In the upper limb there is nothing corresponding in function to the patella, which is a sesamoid bone developed in the tendon of the quadriceps extensor.

The four sections of the extremities are perfectly homologous with each other. Thus, the shoulder = the hip, the arm = the thigh, the fore-arm = the leg, and the hand = the foot; but many difficulties arise on going deeper into the question.

For the better comprehension of the subject the student should place an adult skeleton on all-fours, the position which was most probably normal to our progenitors; he will then observe that the palm of the hand resting on the ground corresponds with the sole of the foot, the thumb with the great toe, the phalanges metacarpal and carpal bones with the phalanges metatarsal and tarsal bones, the malleoli with the styloid processes of the radius and ulna, the tibia with the radius, the fibula with the ulna, the patella with the olecranon, the femur with the humerus, and the scapula with the ilium.

He will notice that in this position of the skeleton the relative position of the bones, as described in handbooks of human anatomy, is much altered. For instance, the radius instead of being external becomes internal; the humerus is rotated in, so that its external condyle becomes internal, and its great tuberosity instead of pointing outwards is directed inwards; and he will see that no knowledge, however extensive and minute of human anatomy only, can understand or explain these homologies. It is to the study of comparative anatomy, embryology, and that department of the evolution theory which is termed Phylogenesis, that we are indebted for what is at present known upon this very interesting subject.

In this position of the skeleton the external humeral condyle (of ordinary human anatomical descriptions) corresponds to the internal femoral,

and the external femoral to the internal humeral condyle. The patella may be regarded as an independent olecranon, but it looks forward while the olecranon looks out and backward. This view is not contradicted by the fact that the radius, the homologous bone to the tibia is moveable on the ulna while the tibia is fixed; this is due to differences in function and does not interfere with their true homologies. The head and neck of the femur and humerus correspond, although for functional purposes the neck of the former is considerably prolonged. The trochanter major is homologous with the great tuberosity of the humerus, although in this position of the body the latter is turned inwards and the former outwards.

The modifications of the general plan in which the three inferior corresponding sections of the upper and lower limbs in the animal series have been produced are in a large measure due to difference of function; to the action of external surroundings; to the influence of heredity in continuing serviceable variations, and to the power inherent in the fitting and survived individuals to perfect and continue the modifications which have proved of most service. In other words, evolution, phylogenesis, and ontogenesis, assisted by the other causes enumerated, have played the chief part in producing the structures of man and other animals as we see them at the present day.

In the upper limb the clavicle is interposed, giving greater breadth and solidity to the shoulders. The humerus is rotated out, and the elbow joint is flexed, with its angle backwards. Pronation and supination are provided for by the joint arrangements between the radius and ulna, which permit rotation of the radius and hand upon it, and the power of opposing the thumb to the other digits is also provided for. It is evident that all these adaptations are suitable to man's erect position, and have reference to the manifold and delicate uses to which his upper limb is subservient.

In the lower limb, which is used as an organ of support and locomotion, the arched form of the pelvic girdle, its being firmly fixed to the vertebræ; the greater strength of its bones; the limited mobility of the thigh at the hip as compared with that of the humerus at the shoulder joint; the turning in of the femur; the forward flexure of the knee; the non-mobility of the two leg bones on each other; the separate position and mobility of the patella; the arched form of the foot; and the non-opposibility of the great toe, have all special reference to the function of this member. The lower one descends in the animal scale the greater modifications are observed, which are manifestly adapted to the different functions which each organism has to perform.

Comparison of shoulder and pelvic girdles.—These offer several homological difficulties, but their analogies are plain as they attach their respective limbs to the trunk. The blade of the scapula corresponds to the ilium, but the latter is firmly united to the lateral mass of the sacrum, whereas the scapula is not articulated with the vertebral column. The coracoid process, which is originally a separate ossification, and which assists in the formation of the glenoid cavity, is represented in the pelvic girdle by the ischium. The scapula and ilium form the *dorsal* parts of their respective girdles, and the *ventral* part is completed in the upper limb by the articulation of the clavicle with the sternum; but in the pelvic girdle there is no very clear homology to the ventral section of the shoulder girdle; in other words, there is in man no bony completion of

the pelvic girdle on its ventral aspect which corresponds to the clavicle. At first sight the fact that the ossa pubis meet at the symphysis seems to offer a similarity to the union of the clavicle with the sternum, and some anatomists look upon them as homologous, but the more accurate study of development and the increasing knowledge in comparative anatomy have led to the rejection of this view, and to the adoption of the idea that the pubes represents the epicoracoid of monotremes and reptiles, and that the coracoid is, as before stated, the representative of the ischium. The os pubis and the clavicle cannot, at present, be said to have their homologies in their corresponding upper and lower extremities. The clavicle, phylogenetically, represents a part of the *dermal* or *exo-skeleton*, and has developed after the manner of the cranial roof-bones. In the pelvic girdle, in which it is not represented, there is a double instead of a single ventral branch (rami of pubes and ischium), which probably corresponds morphologically to the coracoid and epi-coracoid of reptiles and monotremata. Some anatomists have regarded Poupart's ligament as representing the clavicle, and have referred to the position of the subclavian artery passing beneath the clavicle, as indicating its homology with Poupart's ligament, under which pass the femoral artery and vein in a corresponding position; but it has yet to be shown that the subclavian and femoral arteries are homologous to each other, which at present is very doubtful. The marsupial bone of the pouched mammalia has been regarded by some anatomists as representing the clavicle, but its position does not correspond to that structure, as it lies in the median, or superior pillar, of the external inguinal opening.

Rosenberg (Gegenbaur's 'Morphologisches Jahrbuch,' 1876, Bd. 2, p. 238) states, that in man the os pubis is developed independently of the rest of the pelvic girdle. Its homology may perhaps be found in a *pro-coracoid* bone which occurs in some of the lower vertebrates (frogs, tortoises, &c.), and which is situated above and to the proximal side of the coracoid, being ossified from the scapula. The olecranon may represent an occasional isolated bone, the os acromiale, yet this is not homologous to the pro-coracoid, but may be only an independent epiphysis of the scapular spine.

The individual parts of the scapula and ilium offer greater difficulty in their homological determination. In man the dorsum of the ilium appears to correspond to the dorsum of the scapula, and the sub-scapular fossa with the iliac fossa; but if these bones be studied through the vertebrate series a different explanation is compelled from us. Prof. Flower supports the view that the scapula and ilium have become rotated with reference to the axis of their limbs, the former backwards and the latter forwards, in such a way that the pre-scapular fossa (supra-spinous of human anatomy) corresponds to the sacral surface of the ilium; the post-sacral fossa (infra-spinous of man) to the iliac fossa; and the sub-scapular fossa to the gluteal. Prof. Humphry supports the other view, which is that the pre-scapular and iliac fossæ are homologous, and that the post-scapular fossa corresponds with the dorsum ilii or gluteal surface; the sub-scapular being represented by the true pelvic and sacral surfaces of the ilium. If the simpler forms of the scapula and ilium which occur in the animal series be taken as types instead of the more highly developed, the view maintained by Flower seems to be the more probable. In these simpler forms these

bones are chiefly three-sided prismatic rods, in which two external surfaces are separated from an internal surface by an anterior and posterior ridge; and the two outer surfaces are divided by an external ridge which passes from the dorsal portion of these bones to the glenoid and acetabular cavities. This external ridge, which is glenoid in the scapular and cotyloid or acetabular in the ilium, is probably the key to the homologies of these bones. The great extensor of the limb, the triceps in the upper, and the quadriceps in the lower, is attached to it.

To fully understand the homologies of a limb, or part, it is necessary to study and compare not only the bones but the ligaments, muscles, blood-vessels, and nerves, as these often assist materially in furnishing a clue to parts otherwise difficult to homologise.

After considering the skeleton I will therefore point out the main points which have been determined in regard to the soft parts. The student should refer to the accompanying figures, and should also place the skeleton on its face with the arms and legs placed at right angles to the body, with the hand and foot extended and the palm and sole directed towards the ground.

Bones of the Limbs.—In a very early stage of embryonic life, in which the embryo occupies the prone position in the blastoderm, the rudiments of the limbs appear as lateral flat semilunar buds or flaps, which have an upper or dorsal, and a lower or ventral surface. In a later stage the limbs become folded in the ventral direction of the body, but preserve their original relation to the trunk. Their axes now lie perpendicularly to the transverse plane of the vertebral axis, and their position is such that one border looks towards the head and another towards the tail. Profs. Huxley and Flower have named these borders the *pre* and *post-axial*, as indicating their positions anterior and posterior to the limb axis. Comparative anatomy teaches that these limb-buds are formed originally from part of a cartilaginous arch, the limb girdle (shoulder or pelvic), respectively; and this radiating *archipterygium* is likewise developed from this cartilaginous girdle. This archipterygium is attached in a radiating manner to the limb girdle, and at first ends in a point or truncated cone, and its simply divided cartilaginous pieces develop later into the several bones of the respective limbs. Later on, secondary radii are developed from the archipterygium.

At a yet subsequent stage of development, when the *quinquefid* division of the digits becomes apparent, the thumb and radius correspond in position to the great toe and tibia, and occupy the cephalic or pre-axial position. These facts enable us to determine the correspondences of the remaining portions of the limbs with each other; thus, the ulna and fibula correspond, the external condyle of the humerus and the internal tuberosity of the tibia are *cephalic* or pre-axial in position; while the external tuberosity of the tibia and the internal condyle of the humerus are *caudal* or post-axial; the ulna and little finger are in a like position. The upper proximal segments of the corresponding limbs have similar relations: thus, the great tuberosity of the humerus is pre-axial, and the lesser post-axial. The lesser trochanter, internal condyle, tibia, and great toe are cephalic; while the great trochanter, external condyle, fibula, and little toe are caudal. The dorsal or extensor surface of the limbs is external, and the flexor or ventral surface is internal.

The conception of each extremity as an appendicular arch, homologous to the *pharyngeal* or *visceral* arches, making the os hyoides analogous to the os coxarum or its parts, are not so paradoxical as would at first sight appear; because in an early stage of development the upper extremity lies close to the neck, and the lower to the trunk; and Gegenbaur has shown ('Morphologisches Jahrbuch,' 1876, Bd. 3, p. 396) that downward growth-extensions occur in the neighbourhood of the vertebral column at the sites of the future limb girdles; and has also pointed out the occurrence of these in nearly allied species, such as geese and swans for the upper limb, and in the chimpanzee and orang-outang for the lower.

Each upper and lower member is connected with the spinal cord by means of its nerves, which pass to and from it in corresponding inter-vertebral foramina.

This idea, that each extremity is an arch from which the archipterygium is the chief segmented radius, and from which on one, but seldom on two sides, four and rarely five secondary radii proceed, seems to be well founded in embryology and comparative anatomy, and is independent of the hypothesis which compares it to a visceral arch.

The archipterygium or *primary limb ray*, is represented in the upper extremity of man by the humerus, ulna, cuneiform, inner half of the unciform, and the fifth finger. The first, or most proximal, *secondary* ray, which is the strongest, is represented by the radius, scaphoid, trapezium, and thumb. To the second secondary ray belong (for this it appears probable is originally independent), the os intermedium, the radial part of the os centrale, the trapezoid, and the index finger. To the third ray belong the ulnar part of the os carpi centrale, the magnum, and the third finger. The fourth secondary ray ends in the fourth finger. The pisiform is not morphologically a carpal bone, but is a sesamoid bone developed in the tendon of the flexor carpi ulnaris, and physiologically this view is the correct one. It appears not improbable that the pisiforme is a sixth rudimentary ray, of which traces are found in some Urodeles, and even in a sixth finger which is an occasional malformation in man, and in the supernumerary toes of man or other mammals. This sixth ray is directed towards the ulna, and it may be that originally the archipterygium was biserial and provided with rays in two directions, as is the case in the fish Ceratodits. The rudiment of fibular ray of the biserial archipterygium is probably represented in man by the sesamoid fibro-cartilage or bone in the tendon of the peroneus longus, or this latter may represent the rudiment of the sixth toe. It differs, however, from its probable homologue, the pisiform, in that it is more distally placed.

In man and the higher animals developmental changes proceed and soon produce the permanent form in which the humerus is everted and its radial condyle situated outwards; the femur becomes inverted so that its internal condyle is placed inwards. In man the radius is semi-prone, and no further change takes place in its position, so that the thumb hangs naturally forward, but in those lower animals which have to bear part of their body weight upon the palm, the palmar aspect of the hand and fingers acquires this position through the radius being brought forward upon the humerus and its lower end carried inwards so that the thumb or radial digit is inwards. As the femur has already undergone internal rotation in this upper part, no further change is necessary to bring the foot

into its proper position. Through this rotation the great toe, or tibial digit, is on the inner side. In most of the lower animals the fore and hind limbs are permanently placed downwards, whereas in man both limbs are extended in a line parallel to the axis of the body.

Martins regards the humerus as being virtually twisted upon itself to the extent of 90° at the neck, and another 90° from that downwards, in all to the extent of 180° in its length. He accounts by this torsion for the alteration of the position of the external humeral condyle from the typical condition, which, according to him, remains in the femur. He says that if the humerus were untwisted there would be an exact correspondence between the borders and surfaces of the humerus and femur. This appears so probable that Gegenbaur has adopted and illustrated it by additional facts. However, embryology teaches that the external disposition of the lower humeral end does not exceed 90°. The same ingenious anatomist has advanced the view, that in order to discover the homologies of the leg with the forearm it is necessary to regard the upper part of the tibia—which corresponds in the main to the radius—as either including or having had transferred to it the upper part of the ulna and olecranon, and thus he explains the attachment of the quadriceps extensor cruris through the patella to the tibia, instead of to the fibula. According to him the patella corresponds to the olecranon, and although embryology furnishes great objections to these views, yet they cannot be entirely rejected in the present position of the question, although they cannot be considered as forming thoroughly satisfactory explanation of limb homologies.

The homologies between the bones of the forearm and leg offer difficulties which, however, seem to have been solved. But it will be observed that the tibia, which is homologous to the radius, has acquired a greater proportionate growth, while both bones of the forearm have grown in almost equal proportions. This change in the tibia is the resultant of the body weight falling more towards the centre of gravity or mid-line of the body, but the upper ends of the humerus and femur offer somewhat greater difficulties. The femoral neck is, as has been said, homologous to the humeral. Both bones possess a depression at their head, but it is exceptional and occurs only as a variety in man, and its position differs from that on the femur, being much nearer the neck of the bone. In the supposed position the head of the humerus looks downwards, while that of the femur looks upwards; therefore the great humeral tuberosity looks upwards and the trochanter major downwards. For a similar reason the lesser tuberosity looks downwards and the trochanter minor upwards. The fact that the former (in the normal position of the arm) is on the inner or median side of the great tuberosity, and that the trochanter minor is external (in the usual upright position in the leg) to the trochanter major, is accounted for through the strong action of the muscles attached to them in the lower limb, and need not be taken into serious account in the determination of the homologies of the limbs.

The difference between the upper and lower extremities consists in the fact that the former has experienced a strong internal rotation at the shoulder joint, to which must be added the torsion of the lower part of the humerus. In the upper extremity the spiral course of the musculo-spiral nerve (represented by the musculo-spiral groove) indicates the torsion the humerus has undergone, whilst the homologous anterior crural nerve

descends in a straight course. In the thigh this difference of position is perhaps explained by the fact that the femoral artery also courses in a straight line, and also gradually passes to the back of the femur, becoming the popliteal, because the upper part of the femur has also undergone a spiral-like torsion on itself. The course of the artery and nerve betoken the original median or flexor position of the lower extremity.

With reference to the homologies of the forearm and leg, it has already been stated that the patella does not appertain to the tibia as the olecranon does to the ulna, but is simply a large sesamoid bone. The olecranon on the other hand represents the upper epiphysis of the ulna, and arises from three ossific nuclei of which the uppermost and larger was compared by Meckel to the patella. In rare instances the olecranon does not ossify to the ulna but is connected to it by a fibrous tissue, and in this event, provided it be not developed from the upper end of the ulna, may represent the patella; but it is more probable that the sesamoid bone occasionally found in the tendon of the triceps is the true homologue of the patella. The student must be on his guard against mistaking fracture of the olecranon with subsequent fibrous union for a normal structure.

Hand and Foot.—There is no difficulty in determining the homologies of the metacarpal and metatarsal bones and phalanges, which in their form number and relations so well correspond. The opposibility of the thumb, and the greater length and mobility of the digits (which conditions are characteristic of man) constitute the chief differences between the hand and foot.

In comparing the carpal and tarsal bones a general similarity as regards number and position will be obvious, especially in the distal row; but the determination of the homologies of the proximal series offers some difficulties. Of the second carpal row the trapezium, trapezoid, and magnum correspond with the internal middle and external cuneiform of the second tarsal row, and the unciform with the cuboid. In some amphibia and reptiles, especially in Chelonia, the second row of the carpal and tarsal bones consists of five each, through the division of the unciform and cuboid respectively, so that each metacarpal or metatarsal bone has a separate and corresponding carpal and tarsal bone to articulate with it.

In the determination of the homologies of the second series we are much indebted to the researches of Gegenbaur, as indeed are we for much that has been worked out as to the homologies of other portions of the limbs. According to him the most constant, simple, and typical arrangement is that there are three bones, a radial, an ulnar, and an intermedium, which correspond to the scaphoid, unciform, and semilunar bones of human anatomy. The pisiforme he excludes, regarding it as a sesamoid bone in the tendon of the flexor carpi ulnaris. The tarsal, scaphoid, or navicular has no homologue in the hand unless we include the exceptionally occurring os centrale of which I dissected a specimen in the anatomical laboratory of the London Hospital Medical College. It would appear that this bone corresponds to the os centrale together with the detached part of the scaphoid in amphibia, reptiles, and in some mammals, as in Simiæ and Rodents. This central bone is interposed between those of the first and second row, and, more directly, between the scaphoid and lunar and the trapezium and trapezoid. Many circumstances lead to the belief that it is rather a part of one of the proximal bones than really an independent

structure. Some mammals (the carnivora, &c.) have the scaphoid and the semilunar united into one in the adult, the *scaphoid-lunar*, and Flower has shown that there is sometimes in the young dog a separate ossific centre in the distal portion of the scapho-lunar which corresponds in position and connections with the os centrale of other animals; and Wilder has noticed the same occurrence in the carpus of a young lion. In the adults of these animals, however, this portion of bone becomes completely ossified so as to form the scapho-lunar. In some animals the proximal part of the os magnum may separate and form an os centrale.

Some animals possess a *tenth* carpal bone, which appears to correspond to the tubercle of the scaphoid, and Gegenbaur regards this as the typical radial sesamoid, and considers that the tarsal scaphoid may correspond to this along with the os centrale.

The astragalus is homologous to the carpal, scaphoid, and lunar conjoined, or to the radial portions of these bones.

The os calcis is believed to be homologous with the carpal cuneiform, and some anatomists think that it includes the pisiform, but Allen Thomson is of opinion (differing from Gegenbaur in this point) that any one may convince himself of the truth of this latter view by the inspection of the hand and foot of a bear. In a young bear, and also in some other animals, the enlarged pisiforme has an epiphysis exactly similar to that on the tuberosity of the os calcis, and this, according to Allen Thomson, refutes the view that the pisiform corresponds to the calcanean epiphyses.

The most striking difference between the carpus and tarsus seems to be that in the former the os centrale disappears during normal development, while in the tarsus it remains as the scaphoid. In the hand the position of the tarsal navicular is taken by the os radiale, which undergoes a thickening in its palmar portion. In the tarsus the intermedium unites with the os tibiale, which is homologous with the os radiale, to form the astragalus, whilst in the hand the os radiale remains separate from the os intermedium. The tarsal os centrale coalesces also with the astragalus.

TABLE OF THE HOMOLOGOUS BONES OF THE UPPER AND LOWER LIMBS.

Thoracic limb.	*Pelvic limb.*
Scapula.	Ilium.
Precoracoid.	Pubes.
Coracoid.	Ischium.
Glenoid cavity.	Cotyloid cavity.
Clavicle.	Absent.
Humerus.	Femur.
Great tuberosity.	Lesser trochanter.
Small ,,	Great ,,
External condyle.	Internal condyle.
Radius.	Tibia.
Ulna.	Fibula.
Carpus.	Tarsus.
Metacarpus.	Metatarsus.
Pollex.	Hallux.
Phalanges of fingers.	Phalanges of toes.

TABLE OF THE HOMOLOGOUS PARTS OF THE SCAPULA AND ILIUM.

Scapula.	*Ilium.*
Supraspinous fossa.	Sacral and true pelvic surface.
Infraspinous ,,	Iliac fossa.
Subscapular ,,	Gluteal or dorsal surface.
Vertebral border.	Iliac crest.
Spine and acromion.	Ilio-pectineal line and eminence (?).
Superior angle.	Posterior superior spine.
Inferior ,,	Anterior superior spine.
Superior border.	Posterior or ischial border.
External or glenoid border.	Anterior or cotyloid border.

TABLE OF THE HOMOLOGOUS BONES OF THE CARPUS AND TARSUS.

(Modified from Gegenbaur.)

Carpus. *Typical names.*	*Nomenclature of Human Anatomy.*		*Tarsus.* *Typical names.*
Radiale	Scaphoid	Astragalus	Tibiale.
Intermedium	Lunar		Intermedium.
Ulnare	Cuneiform	Os calcis	Fibulare.
Ulnare sesamoideum	Pisiform		Fibulare sesamoideum.
Centrale	Part of scaphoid or other bone.	Navicular	Centrale.
			Tibiale sesamoideum.
Radiale sesamoideum	Part of scaphoid.		
Carpale I.	Trapezium	Int. cuneiform.	Tarsale I.
,, II.	Trapezoid	Mid. ,,	,, II.
,, III.	Magnum	Ext. ,,	,, III.
,, IV.	Unciform	Cuboid	,, IV.
,, V.			,, V.

If the pisiform be left out of consideration as a carpal bone, the following scheme represents the probable homologies according to Krause.[1]

Carpus.	*Tarsus.*
Radiale.	Astragalus.
Intermedium.	
Ulnare.	Calcaneus.
Centrale.	Navicular.
Carpale I.	Tarsale I.
,, II.	,, II.
,, III.	,, III.
,, IV.	,, IV.

HOMOLOGIES OF THE LIGAMENTS.

These offer little difficulty, as from their position, relations, and developmental history they are easily made out. For instance, the coraco-humeral of the shoulder, and ischio-femoral of the hip correspond. The ligament between the radius and ulna and tibia and fibula, the annular ligaments of the wrist and ankle, and the deeper ligaments of these parts and of the hand and foot, all correspond. The piso-uncinate ligament corresponds to the expansion of the peroneus longus to the cuboid, and the

[1] Sabatier's recent work, *Comparaison des ceintures et des membres antérieures et postérieures, dans la série des vertébrées*, 1880, contains valuable information on the subject of limb homologies.

tendon of this muscle to the reflected part of the piso-metacarpal ligament. The ligamentum teres of the hip may appear to offer difficulty, but this is solved by the fact that there is an occasional corresponding ligament in the shoulder; there is, however, nothing homologous to the crucial ligaments of the knee in the elbow. The orbicular ligament between the radius and ulna is interarticular, it is true, but does not correspond with the crucials either homologically or physiologically, as the latter connect the tibia and femur, whereas the orbicular unites the two bones of the forearm. I have on two or three occasions noticed thickened processes of the synovial membrane of the elbow, passing from the trochlea in front and behind to the margin of the larger ulnar sigmoid cavity. These may be analogous to the crucials, but I can scarcely regard them as homologous. I should state that two of these subjects, the one male and the other female, were elderly, and it may be supposed that these processes were pathological, but the joint surfaces gave no obvious indications of disease; the third was a younger subject, and free from any arthritic mischief. The semilunar fibro-cartilages of the knee are entirely unrepresented in the elbow, and it may be that the difference of function of the upper limbs, due to our upright position, has caused the disappearance of structures which may have existed in our progenitors which (although not pointed out by any other anatomist so far as I am aware) are undoubtedly homologous to them. For instance, in the dog and cat the lower portion of the external lateral ligament forms a thick fibro-cartilaginous cap, which is fixed on the radius and ulna and is united to the anterior ligament and to the annular orbicular ligament of the superior radio-ulnar joint, and although in these animals this cap completes the osteo-fibrous ring in which the upper end of the radius revolves, still, being interposed between the humerus and bones of the forearm it must act as a buffer in the same way as do the menisci of the knee. The human knee joint is occasionally divided into two parts, an outer and inner, by a median partition of synovial membrane, and this condition is found normally in some lower animals.

MUSCULAR HOMOLOGIES.

General Morphology.—In most of the lowest vertebrates and in early stages of human fœtal development the muscles, as a whole, are in groups corresponding closely to the skeletal ground plan of the organisation of vertebrates. Fishes and some amphibians possess in a high degree the vertebrate segmentation, the muscles being partitioned into zones or segments termed *myotomes* by divisions or partitions called *sclerotomes*, which may be membranous, cartilaginous, or bony, and which pass transversely from either side of the vertebral column through the body walls, and correspond in position and number of segments with the vertebræ and ribs. It is very difficult in man and the higher animals to trace the homologous axial muscles, on account of the greater degree of specialisation of the muscles in connection with the limbs. In the deeper trunk-muscles however the typical vertebrate subdivision may be traced, but in the more superficial muscles of the trunk, and especially of the limbs, portions of the myotomes coalesce so as to form muscles of greater or less length, and this is to a great extent due to the extension down and outwards from the trunk of these structures.

Professor Huxley has named the two sets of muscles which lie above and below the embryonic vertebral axis, the *epi-* and *hypo-skeletal*, respectively, and these terms correspond to the *epaxial* and *hypaxial* of other writers. In man the latter group is little developed, and is chiefly represented by the nuchal prevertebral muscles, and by the transversus abdominis. The epaxial muscles are divisible into a *dorso-lateral* and *ventro-lateral* group. The former consists chiefly of the long and short erector muscles of the spine and head, and in the latter division are included the longitudinal muscles, such as the rectus abdominis, sterno-hyoid, and genio-hyoid. The ventro-lateral group include the sterno-mastoid, scalenes, intercostals, and flat abdominal muscles; the limb muscles also come primarily from this ventro-lateral mass. When muscles are attached partly to the trunk and partly to the limbs they are called *extrinsic*, but when attached entirely to the limb girdles and the limb segments they are termed *intrinsic.*

Homological correspondences are found not only between individual muscles and muscular groups of man, but also between human muscles and those of inferior animals; but as their attachments, relations, form, and actions vary greatly in different animals in consequence of the different functions which they have to perform, and as there are frequent varieties in the same species and often in the same individual, the exact determination of the homologies is a matter of considerable difficulty and is consequently, at present, not thoroughly ascertained. The frequently occurring muscular varieties in man taken in consideration with the fact that they are generally repeated in the same form or some modification of it, points to the present or past existence of some fundamental and typical form in the animal series, and many of these so-called varieties are almost exact representations of forms which exist in different species of animals lower in the scale. I believe that if the attachments, forms, and relations of all these so-called varieties were regularly noted and compared, we should in a short time possess sufficient data to be able to trace the life-history, and consequently the true homologies, of the muscular system. The student must be awakened to the fact that varieties occur in the lower animals as well as in man, and are subject to a similar explanation.

Special Morphology.—In the pelvic limb there are two muscles of which the homologies in the thoracic appendage have not yet been determined: these are the psoas and pyriformis. The former passes to the pre-axial antero-internal aspect of the limb; the other to its post-axial or postero-external aspect. The bud-like process from the side of the embryo receives, probably, an enveloping sheath of muscular tissue from the ventro-lateral division of the epiaxial group, and this envelope is at first a simple investing infundibulum or funnel, but in process of growth it undergoes segmentation concurrently with the breaking up of the bony parts into the future sections of the limb. The superficial fibres of this sheath often pass entirely over one segment to more distal parts, but the deeper fibres pass, usually, from one segment to the next. Prof. Humphry thinks that two of the three layers into which the axial ventro-lateral group divides may be traced into its limb segments, and that they correspond to the external oblique and superficial part of the internal oblique layers. In the thoracic member the first segment of this muscular sheath is longer and its parts more easily recognised. This is due to the more

superficial position and freedom of motion of the shoulder girdle, but the muscles of the pelvic girdle are not differentiated to the same extent. The superficial layer of the muscles of the anterior extremity, which may be termed the axio-appendicular group, divides at the shoulder girdle into three chief masses. In front are the pectorales, behind and above are the sterno-mastoid and trapezius, the latter passing as the deltoid to the humerus, and below and behind is the latissimus dorsi. On the deep surface of this last muscle are its occasional scapular attachment and the teres major and minor, and beneath the trapezius are the rhomboids. The muscles forming this layer are often found united as regular structures in some of the lower animals, and as varieties in man, but the majority of these latter seem to be reversions to a fundamental type. The frequently found axillary arches or muscular loops seem to indicate an imperfect segmentation. The pectoralis major in a few of the lower animals is entirely continuous with the external oblique, but in man it is only united to its superficial fibres. In animals which either have no clavicle or a very rudimentary one, the sterno-mastoid coalesces with the anterior part of the trapezius and runs into the deltoid, forming a mastoido-humeral muscle. In man it is in close relation with the clavicular portion of the pectoralis major, being separated from it only by the clavicle.

The deep layer of the axio-appendicular muscles is much less complete than the superficial, and is attached to the thoracic girdle in two divisions in front and behind the glenoid cavity. In the former position, and attached to the coracoid process, is the costo-coracoid which represents the subclavius; and in the latter are the costo-scapular group, including the serratus magnus, the levator anguli scapulæ, and the omo-hyoid, which are attached to the scapula. In the lower extremity those muscles only which pass beyond the girdle to the limb are found distinct, and the axio-appendicular muscles are mainly represented by the abdominal oblique muscles. The pectoralis corresponds with the gracilis; the trapezio-deltoid with the anterior part of the external oblique and pectineus; the latissimus dorsi with the gluteus maximus, both of which are inserted into the post-axial border of their corresponding limb. The pectineus and gracilis are inserted into the pre-axial border, but the former seems to consist of two parts, of which the outer may correspond with the pectoralis major and deltoid, and the inner with the subclavius. The muscles already described belong to the *extrinsic* group.

The *intrinsic* muscles include all the others pertaining to the limbs, and are placed in groups in relation to its several segments, and correspond homologically with each other. They are situated mainly on the dorsal and ventral aspects of the limbs, are on the pre- and post-axial borders of these members, and are flexors and extensors or pro- and retractors.

Much difficulty exists in the determination of the muscular homologies of the thoracic and pelvic limbs, more especially in their proximal segments, but in the distal segments, the muscles, although more numerous, become shorter and more regular in their arrangement, and consequently the homologous muscles of the hand and foot are more easily made out. In the proximal segments the flexor surface of the upper limb has been twisted forwards, and in the lower limb it has been turned backwards, and this increases the difficulty of homological determinations, and the additional fact of the preponderance of the pre-axial tibia over the post-

axial fibula in the second segment of the pelvic appendage, as opposed to the preponderance of the upper end of the post-axial ulna over the pre-axial radius, further increases this difficulty, as muscles which are most probably homologous have, as a consequence of this difference in position, different insertions. In cases of difficulty the homologies may perhaps be determined by reference to the origins, some of which are fairly constant. Thus for instance the triceps, the great extensor of the forearm, is inserted into the post-axial ulna; while the quadriceps, the extensor of the leg, is inserted into the pre-axial tibia, and yet the justness of their homological comparison is indicated by the fact that their origins are from corresponding portions of the bone segments.

This statement as to the muscular origins may seem to contradict what has already been said with reference to the homology between the latissimus dorsi and the gluteus maximus, as the former does not arise from the shoulder girdle in the same way that the latter does from the pelvic girdle; but other considerations have led to the belief expressed, and the student, instead of being bewildered and discouraged by this apparent arbitrary use of determining data, must recollect that various causes, some superior and others inferior, have led to modifications of structure which can only be solved by recognising the various processes which have contributed to this apparent difference but really hidden similarity.

TABLE OF HOMOLOGIES OF THE LIMB-MUSCLES. (KRAUSE.)

Thoracic limb.	*Pelvic limb.*
	Psoas magnus.
Subscapularis.	Iliacus.
Deltoid, acromial part.	Gluteus maximus.
Coraco-brachialis.	
Supra-spinatus.	Gluteus minimus.
Infra-spinatus.	,, medius.
Teres major.	
,, minor.	
	Pyriformis.
	Bursalis.
	Obturator externus.
	Quadratus femoris.
	Tensor fasciæ latæ.
	Sartorius.
	Gracilis.
Quadrigeminus brachii,[1] short head and tendon.	Semitendinosus.
Quadrigeminus short head and aponeurosis.	Biceps femoris, long head.
Quadrigeminus long head and tendon.	Semimembranosus.
Brachialis anticus.	Biceps femoris, short head.
Triceps brachii and anconeus.	Quadriceps femoris.
,, ,, long head.	Rectus femoris.
,, ,, ext. head and anconeus.	Vastus internus.
,, ,, middle.	,, ext. and crureus.
Subanconeus.	Subcrureus.
	Pectineus.
	Adductor longus.
	,, brevis.
	,, minimus.
	,, magnus.

[1] The German name for the biceps.

Table of Homologies of the Limb-muscles. (Krause)—*continued.*

Thoracic limb.	*Pelvic limb.*
Supinator longus.	
Ext. carpi radialis longior.	
,, ,, brevior.	
,, communis digitorum	Ext. longus digitorum.
,, minimi digiti.	Peroneus tertius.
,, carpi ulnaris.	Peroneus brevis.
Supinator brevis.	
Ext. ossis metacarpi poll.	Tibialis anticus.
,, primi internodii poll.	Variety of ext. hallucis longus.
,, secundi ,, ,, ,, indicis.	Extensor hall. long.
	Triceps suræ.[1]
Flexor carpi ulnaris.	Peroneus longus.
Pronator teres.	Popliteus.
Flexor carpi radialis.	Tibialis posticus.
,, sublimis dig. and palmaris.	Flex. brevis dig. and plantaris.
,, profundus dig.	,, longus dig.
,, longus pollicis.	,, ,, hallucis.
Pronator quadratus.	Variety. Pronator pedis.
Variety. Ext. dig. manus brevis.	Ext. brevis dig. pedis.
	Quadratus plantæ.[2]
Lumbricales.	Lumbricales.
Abductor pollicis Opponens ,,	Abductor hallucis.
Flex. brevis pollicis.	Flex. brev. ,,
Adductor pollicis.	Adductor ,,
Abductor min. dig.	Abductor min. dig.
Flex. brevis min. dig.	Flex. brevis min. dig.
Opponens min. dig.	Opponens min. dig.
Dorsal Interosseous I.	Dorsal Interosseous I.
,, ,, II.	,, ,, II.
Palmar ,, I.	Plantar ,, I.
Dorsal ,, III.	Dorsal ,, III.
Plantar ,, II.	Plantar ,, II.
Dorsal ,, IV.	Dorsal ,, IV.
Plantar ,, III.	Plantar ,, III.

Krause omits the palmaris brevis, which is, however, usually unrepresented in the hand.

Table of Homologies of the Limb-muscles. (Allen Thomson.)

I. Muscles passing from Trunk to Limbs or their Girdles.

Upper Limb.[3]	*Lower Limb.*
1. Trapezius.	1. Lumbar aponeurosis, &c.
1*a*. Cleido-mastoid and sterno-mastoid. 1*b*. Rhomboids.	1*a*, *b*. External oblique.
2. Levator scapulæ. 2*a*. Serratus magnus.	2, 2*a*. Internal oblique. Transversalis. Quadratus lumborum.
3. Latissimus dorsi.	3. Gluteus maximus.
3*a*. Teres major.	3*a*. Tensor vaginæ femoris.
4. Pectoralis major.	4. Gracilis. Part of pectineus?
4*a*. Pectoralis minor.	4*a*. Coccygeus?
4*b*. Subclavius (second pectoral of birds, Rolleston).	4*b*. Inner or deep head of pectineus, supplied by obturator nerve (Rolleston)?
5. Omohyoid.	5. ?

[1] This is the name for the gastrocnemius (two heads) and soleus.

[2] Synonymous with flexor accessorius.

[3] The numbers affixed to the several muscles in the two columns are intended merely as a means of facilitating the reference from one to the other, the upper limb being taken as the standard of comparison. The names of muscles printed in italics are those of varieties more or less frequently found in human anatomy.

II. Muscles passing mainly from Girdle to Limb.

6. Deltoid { 6a. Scapular part. 6b. Clavicular part.	6a. Sartorius. 6b. Pectineus, outer head supplied by anterior crural nerve (Rolleston).
7. Supra-spinatus.	7. Obturator internus?
7a. Infra-spinatus.	7a. Iliacus.
7b. Teres minor.	7b. *Iliacus minor* (Luschka).
8. Subscapularis.	8. { Gluteus medius. Gluteus minimus.
9. Coraco-brachialis. a, b, c. *Upper*, middle and *lower* parts.	9a, b, c. Three adductors, with perhaps obturator externus.
10. Biceps flexor cubiti. a. Scapular head. b. Coracoid head.	10a, b. { Ischial head of biceps femoris. Semimembranosus. Semitendinosus.
c. *Humeral head.* 10d. Brachialis anticus.	10c. Femoral head of biceps femoris.
11. Triceps extensor cubiti. a. Scapular head. b. External humeral head. c. Internal humeral head.	11. Quadriceps extensor cruris. a. Rectus femoris. b. Vastus externus. ,, internus. Crureus.

III. Muscles passing over Elbow and Knee Joints, and acting on the relative position of the Bones of the Forearm and Lower Leg.

Upper Limb.	*Lower Limb.*
11. Supinator radii longus.	11. ?
12. ,, ,, brevis.	12. ?
13. Pronator ,, teres.	13. Popliteus.
14. ,, quadratus.	14. *Peroneo-calcaneus internus* (Macalister).

IV. Muscles passing over Wrist and Ankle Joints.

A. *To the carpus and metacarpus or to the tarsus and metatarsus.*

15. Extensor carpi radialis longior. 15a. ,, ,, brevior.	15. Tibialis anticus.
15b. ,, ossis metacarpi pollicis.	15b. *Extensor ossis metatarsi hallucis*, or with the preceding muscle.
16. ,, carpi ulnaris.	16. Peroneus tertius.
17. Flexor carpi radialis.	17. Tibialis posticus.
18. ,, ,, ulnaris.	18. Peroneus brevis, and in intrinsic muscles of the calf.
19. ?	19. Peroneus longus.

B. *To the digital phalanges.*

20. Extensor com. digit. longus.	20. Extensor com. digit. long.
20a. ,, secundi internod. poll.	20a. ,, long. hallucis.
21a. ,, primi internod. poll.	21a. First slip of ext. brevis digit.
21b. ,, indicis.	21b. Second slip of ext. brevis digit.
21c. ,, minimi digiti.	21c. *Occasional slip of peroneus tertius.*
22. Flexor digitorum profundus.	22. Flexor digitorum longus.
22a. ,, longus pollicis.	22a. ,, longus hallucis.
23. ,, digitorum sublimis.	23. ,, digitorum brevis.
24. Palmaris longus.	24. Plantaris, and flexors?

V. Muscles confined to the Hand and Foot.

25. Tendons of extensores secundi internodii pollicis, indicis, and minimi digiti.	25. Extensor communis digitorum brevis.
26. Abductor pollicis.	26. Abductor hallucis.
27. Flexor brevis pollicis, inner head. a. outer head.	27. Flexor brevis hallucis. 27a. Adductor hallucis obliquus.

V. Muscles confined to the Hand and Foot—*continued.*

27*b*. Opponens pollicis.	27*b*. *Opponens hallucis.*
28. Adductor pollicis.	28. Transversus pedis.
29. Tendons of flexor profundus digitorum.	29. Flexor communis digitorum brevis.
30. Palmaris brevis.	30. ?
31. Abductor minimi digiti.	31. Abductor quinti digiti.
32. Flexor brevis minimi digiti.	32. Flexor brevis quinti digiti.
33. Opponens minimi digiti.	33. *Opponens quinti digiti.*
34. Interossei, dorsal and palmar.	34. Interossei, dorsal and plantar.
a. Radialis secundi digiti (dors.)	*a*. Tibialis secundi digiti (dors.)
b. Ulnaris sec. dig. (palm.)	*b*. Fibularis sec. dig. (dors.)
c. Radialis medii (dors.)	*c*. Tibialis tertii (plant.)
d. Ulnaris ,, ,,	*d*. Fibularis tertii (dors.)
e. Radialis quarti (palm.)	*e*. Tibialis quarti (plant.)
f. Ulnaris quarti (dors.)	*f*. Fibularis quarti (dors.)
g. Radialis quinti (palm.)	*g*. Tibialis quinti (plant.)
35. Lumbricales quatuor, radiales sec. tert. quart. et quint. digit.	35. Lumbricales quatuor, tibiales sec. tert. quart. et quint. digit.

The above tables sufficiently explain the majority of the corresponding muscles, especially if one compare their respective origins and insertions; but others require some further explanation.

The triceps humeri and quadriceps femoris are homologous according to the following plan:—

Upper extremity.		*Lower extremity.*
Triceps, long head	=	Rectus femoris.
,, middle head	=	,, crureus and vastus externus.
,, external head and anconeus	=	,, vastus internus.

The difference between the arm and the leg is shown by the fact that the deepest fibres of the vastus internus, which corresponds to the anconeus, pass with the others to be inserted into the tibia, whilst in the arm the anconeus is separated from the external head of the triceps, and is inserted, independently, into the ulna.

The biceps brachii is homologous to the combined semitendinosus, semimembranosus, and long head of the biceps. Krause says, that more accurate dissections tend to show that it is four-headed and resembles the quadrigeminus capitis or sterno-mastoid, and that it should be called the quadrigeminus brachii, because it possesses four independent portions represented in the following plan:

Upper limb.		*Lower limb.*
Quadrigeminus brachii. Short head and aponeurosis.	Coraco-ulnaris.	Biceps femoris, long head.
Short head and tendon.	,, radialis.	Semitendinosus.
Long head and tendon.	Gleno-radialis.	Semimembranosus and its tibial tendon.
Long head and aponeurosis.	Gleno-ulnaris.	Is either absent or represented, through the union at their origins, of the semimembranosus and long head of biceps.

The space at the bend of the elbow corresponds morphologically with the popliteal space, but the latter is diamond-shape and the former

triangular. In this *trigonum cubitale* are found the termination of the brachial artery and the median nerve, whereas the popliteal artery and nerves are found in the popliteal region. The pronator teres corresponds in its origin, course, and action with the popliteus, and this homology is occasionally rendered more striking through the occurrence of a sesamoid bone in the tendons of both muscles. The lower end of the brachial artery lies on the dorsal or extensor side of the pronator teres, but the popliteal lies behind and on the flexor side of the popliteus, which makes it more probable that only the ulnar head of the pronator teres is homologous with the popliteus. The peroneus brevis has some similarity in its insertion to the extensor carpi ulnaris, but the difference between their origins will only permit of an homology if one assume that the origin of the peroneus brevis originally extended proximally to the external femoral condyle. Some varieties of both muscles lend support to this view.

The palmaris longus and plantaris appear to be homologous, but require further consideration. In the hare the plantaris is a strong muscle, but this animal does not possess a flexor sublimis digitorum; however, the palmaris may be conceived as a separate muscular band of the flexor digitorum sublimis, so that the flexor sublimis digitorum, palmaris, and plantaris may be considered together as being homologous with the flexor brevis digitorum.

The similarity between the small special muscles of the hand and foot is obvious. The ab- and adductors may be considered as specially developed interosseous muscles. The short flexors of the fingers and toes lie comparatively deep, and have no relation to the flexor brevis digitorum. The opponens pollicis of the hand appears to be absent in the foot, but this is really not the case, as it is represented through a bundle of fibres of the abductor hallucis.

The interosseous muscles of the hand and foot are homologous with the exception that the first palmar interosseous is attached to the ulnar side of the second finger, whereas the first plantar interosseous is fixed on the tibial side of the third toe; conversely, the second dorsal interosseous of the hand is inserted on the radial side of the third finger, but the second dorsal interosseous of the foot is attached to the fibular side of the second toe. These differences have been explained by supposing that the long axis of the hand passes through the phalanges of the middle finger, but in the foot through those of the second toe; these variations indicate gaps in our present knowledge of the corresponding muscles of the upper and lower limbs.

Nerve distribution would probably give the simplest explanation of these different relations between the interossei of the hand and foot, especially if the thumb and great toe be considered not to be homologous with each other. In this view the hallux would represent the thumb and index finger together, the little finger would correspond to the fourth toe, and the fifth toe would represent a sixth ray. Originally there were six digits in the hand and foot, the sixth persists in the foot and disappears entirely in the hand. The first and second are represented in the upper limb by the thumb and index finger, and below by the great toe. This view is supported by phylogenetic facts, so that in apes the phalanges of the third foot-digit is that one which possesses two dorsal interossei, instead of the second one, as in man.

Dr. D. J. Cunningham, in the October number of the 'Journal of Anatomy and Physiology,' in an article on *The Relation of Nerve-supply to Muscle-homology*, while agreeing in the main with Ruge's views as to the importance of nerve-supply in determining muscle homologies, differs from him as to its infallibility, and says 'that the doctrine of the invariable relation between-nerve supply and muscle homology is an erroneous one and contrary to existing fact. The value of this feature, however, in the determination of the history of a muscle cannot be overrated. Indeed, it is equalled in importance only by the "insertion." I am tempted to bring forward, from human anatomy, an illustration to show its importance, and how, if attention had been paid to it, a more consistent nomenclature might have been employed. I refer to the short muscles of the thumb. In our text-books these are described as consisting of an abductor, a flexor brevis (composed of a superficial and a deep head), an opponens, and an adductor. The opponens may be left out of count, seeing that it is a derivative from the outer head of the flexor brevis.[1] These muscles are supplied by the median and ulnar nerves. The median gives branches to the abductor and the outer head of the flexor brevis. The ulnar supplies the adductor and deep head of the flexor brevis.

'If we now turn to the foot, we find that both heads of the flexor brevis and the adductor of the great toe are supplied by the internal plantar, which is the median of the pes, whilst the adductor and transversalis pedis are furnished with twigs from the external plantar or ulnar of the foot. Here there is a marked discrepancy, but it is only an apparent one. The truth is, that the adductor pollicis is the serial homologue of the transversus pedis, and the deep head of the flexor brevis pollicis the serial homologue of the adductor hallucis. The abductor and outer head of the flexor brevis pollicis correspond with the abductor and inner head of the flexor brevis hallucis. But where is the true inner head of the flexor brevis pollicis? This is a muscular slip, which is almost invariably present, but owing to the great development of the adductors it has been thrust deeply into the palm. It is in the *interosseus primus volaris* of Henle.

'Lastly, it is not at all unlikely—indeed, that it is highly probable—that the sources in the brain or spinal cord from which the nerve fibres destined for the supply of a certain muscle are derived, are invariably the same. Of this, however, we have little proof. It is a matter of certainty, as we have seen, that these fibres may adopt different nerve strands in order to reach the muscle. Even in the human body great numbers of examples of this may be quoted. Thus the long buccal nerve has been observed by Professor Turner to proceed from the superior maxillary division of the fifth; again, every demonstrator of anatomy has observed the descendens noni taking its origin from the vagus instead of the ninth nerve; and the frequency of the accessory obturator and the accessory phrenic nerves is a fact of common knowledge.'

Professor Rolleston[2] was one of the first to recognise the importance of nerve supply as more important than the position, attachments, and relations in determining the homologies of muscles; and Bischoff, ten

[1] Ruge, *Morph. Jahrb.*, 1878, p. 137.

[2] 'On the Homologies of certain of the Muscles connected with the Shoulder-girdle.'—*Transactions of Linnean Society*, vol. xxvi.

years ago, pointed out the serial homologies between the short muscles of the thumb and great toe in his elaborate memoir on the *Hylobates leuciscus*, but Dr. Cunningham arrived independently at the same results, through his researches into the comparative anatomy of the intrinsic muscles of the foot.

COMPARATIVE TABLE OF MUSCULAR HOMOLOGIES OF THE SHOULDER AND PELVIC GIRDLES IN MAN AND THE SUPERIOR MAMMALS.[1]

FIRST CATEGORY.—MUSCLES CONNECTING THE TWO GIRDLES TO THE TRUNK.

Shoulder girdle.	*Pelvic girdle.*
Ext. intercostals.	Ext. oblique of abdomen.
Int. ,,	Int. ,, ,,
Triangularis sterni.	Transversus ,,
o. Presternal aponeurosis (sterno-costal, supracostal).	Rectus and pyramidalis.
Scalenes and cervical intertransverse.	Quadratus lumborum.
Trapezius.	o. Lumbar aponeurosis.
Rhomboids.	o. ,, ,,
Levator anguli scapulæ.	o. Ilio-lumbar ligaments, superior and inferior.
Omohyoid. Serratus magnus.	o. Interosseous sacro-iliac ligaments.
Pectoralis minor.	Pubic and aponeurotic part of levator ani and ischio-coccygeus.
o. Subdeltoid aponeurosis (part).	Sciatic part of levator ani.

SECOND CATEGORY.—MUSCLES CONNECTING THE UPPER SEGMENT OF THE LIMB EITHER TO THE TRUNK OR GIRDLE OR TO BOTH.

Pectoralis major.	Pyramidalis.
Trapezius (clavicular part). Deltoid ,, ,, Sterno-mastoid. (Mastoido-humeral of non-claviculate mammals.)	Psoas magnus.
o. Superficial cervical aponeurosis (part).	Psoas minor.
Subscapular (part in the fossa of anterior scapulum).	Iliacus.
Subscapular (part in posterior scapulum).	Obturator int. { Sciatic part. Pubic ,, Iliac ,,
Teres minor.	Obturator ext. { Sciatic part. Pubic ,, Iliac (gluteus minimus).
Supra and infra-scapular.	Gluteus medius.
Latissimus dorsi.	
Teres major.	
Deltoid (part).	Gluteus maximus. Tensor fasciæ latæ.
,, (subspinous part).	o. Superficial aponeurosis of gluteus medius.
,, (spinal part).	o.
Precoraco-brachial.	Pectineus. Superficial adductor longus (second). Small deep adductor.
o.	Adductor magnus. Quadratus femoris.

[1] According to A. Sabatier, *Comparaison des ceintures et des membres antérieurs et postérieurs dans la série des vertébrés*, 1880, p. 321. o = either absence or is followed by the probable representative.

THIRD CATEGORY.—MUSCLES CONNECTING THE SECOND LIMB SEGMENT TO THE GIRDLE.

Shoulder girdle.	*Pelvic girdle.*
Short head of biceps.	Gracilis.
Long „ triceps.	Long head of triceps.
„ „ biceps.	Rectus. Sartorius. Semitendinosus. Semimembranosus.

FOURTH CATEGORY.—MUSCLES CONNECTING THE FIRST AND SECOND LIMB SEGMENTS.

Vastus externus brachialis.	Inner head of vasti.
„ internus „	Outer „
Brachialis anticus.	Short head of biceps.
o. In man: the radial part of the anterior brachial in other mammals.	Popliteus.

HOMOLOGIES OF THE BLOOD-VESSELS.

Only a general correspondence can be established between the blood-vessels of the upper and lower limbs. This is partly due to the want of more exact knowledge of their development. In early fœtal life there are no distinct large vessels, the parts being nourished through vascular net-works, and it is by the enlargement of one or more of these that the main arterial and venous trunks of the limbs are developed, and this takes place in a different direction in the thoracic and pelvic members, which causes the somewhat different appearance of these structures in the adult.

The analogy between the brachial and femoral arteries is clear, but they are not homologous. The brachial is represented in the lower limb by the small ischial branch of the sciatic artery. At first this branch anastomoses with the popliteal through the superior articular, and thus the popliteal is homologous with the lower parts of the brachial as well.

In the forearm and leg the vessels appear to be homologous, but they are in reality rather analogous than homologous, the radial representing the anterior tibial, the ulnar the posterior tibial, and the common interosseous the peroneal.

Physiologically, these vessels correspond in fulfilling a similar function, which is to supply certain sections of their respective limbs with blood, but their positions and relations are different. The anterior and posterior circumflex in the arm are analogous to the external and internal circumflex in the thigh, but not homologous. The brachial artery divides into the radial and ulnar; the latter corresponds to the archipterygium, the former to the first secondary ray, radius, radiale, trapezium, and bones of the thumb.

The common interosseous belongs to the second secondary ray, i.e. to the intermedium, trapezoid, and index finger. The third and fourth secondary rays and their corresponding fingers are nourished chiefly through the third and fourth palmar digitals.

In the lower limb the anterior tibial, up to the point where the malleoli are given off, represents the radial. The common and posterior peroneal and lower part of the posterior tibial represent the ulnar. The anterior peroneal corresponds to the anterior interosseous, but the posterior interosseous of the forearm is represented by the anterior tibial. The posterior tibial may be considered as a vessel which has gradually received

its blood from three different sources: first, from the peroneal, secondly from a *saphena artery*, which, as comparative anatomy teaches, is, in the foot of many mammals, the direct continuation of a vessel running superficially and accompanying the saphena vein. This vessel has no homologue in the hand, unless an occasionally occurring branch which accompanies the cephalic vein (a superficial radial), and either joins the radial proper or is continued into the hand, be considered as such. Thirdly, the saphena artery having disappeared, and the peroneal and posterior malleolar having diminished in size, the lower part of the posterior tibial derives its blood directly from the upper part of the same vessel, which part is homologous to the radial. Thus is explained the correspondence in size between the homologous posterior interosseous of the forearm and the anterior tibial, whilst the dorsal artery of the foot corresponds to the termination of the radial; but, as already said, the upper part of the posterior tibial is homologous to the radial.

Comparative anatomy, as well as the positions and relations of the vessels in man, and the homologies between the bones and muscles of the two limbs, tends to confirm the above views of the arterial homologies, and the study of varieties strengthens this explanation. For instances not a few are known in which the sciatic is directly continued into the popliteal (a posterior femoral), whilst the femoral was undeveloped, the main artery of the lower limb coursing in its original normal position with the sciatic nerve, which latter is homologous with the median and ulnar nerves. (In birds the femoral is a continuation of the sciatic.) According to this, the femoral corresponds to the superior profunda which runs with the musculospiral nerve, and which is homologous to the anterior crural nerve.

As illustrative of the varieties of the arteries of the leg, may be mentioned the fact that when the posterior tibial is diminished, a large peroneal takes its place. If the posterior tibial be absent, the peroneal not only gives off branches which come usually from the posterior tibial, but even in its course and distribution takes the place of the missing artery. Should the anterior tibial be small and terminate in the leg, its resemblance to the dorsal or posterior interosseous of the forearm is more striking. The common and anterior interosseous are not represented in the lower limb.

The anastomoses around the elbow and knee joints are homologous and analogous, as are those around the wrist and ankle. The palmar and dorsal interossei of the hand and foot correspond, as do the carpal and tarsal dorsal arches, but there is no superficial plantar arch corresponding to the superficial palmar, although the deep palmar and plantar arches correspond. The peroneal artery, which is homologous with the ulnar, bends at a right angle towards the tibia, then passes downwards also at a right angle and returns, in the sole, in an arched manner, so as to end in the commencement of the plantar arch. In this way the commencement of this arch is placed in the direction of the course of the artery.

The superficial palmar arch is sometimes represented in the foot by a variety known as the superficial plantar arch. Normally, this is absent, because the homologue of the superficiales volæ is much diminished or absent in the foot (probably as a consequence of the growth of the os calcis), and this vessel is only represented in the foot by the termination of the posterior peroneal.

Table of Homologous Limb Arteries.

Thoracic limb.	*Pelvic limb.*
Brachial.	Ischial branch of the sciatic and popliteal artery.
Superior profunda.	Femoral and its musculo-articular branch in vast. int. and anastomotica magna.
Anterior circumflex.	External circumflex.
Median collateral.[1]	Descending branch of ext. cirflex.
Posterior circumflex.	Internal circumflex.
Anastomoses round elbow.	Anastomoses round knee.
Radial.	Posterior tibial in leg.
Ulnar.	Common peroneal. Posterior tibial in foot.
Ulnar metacarpal.	Posterior peroneal.
Dorsal or posterior interosseous.	Anterior tibial, in leg.
Anterior carpal arch.	Anastomoses around os calcis.
Posterior ,, ,,	Dorsal tarsal arch.
Dorsal interosseous.	,, interosseous.
,, digital.	,, digital.
Deep palmar arch.	Plantar arch.
Palmar interossei.	,, interossei.
,, digital.	,, digital.

The *Veins* partake of the homologies of their corresponding arteries. The superficial veins of the forearm and arm, viz. the median basilic, the median cephalic, the cephalic, and basilic represent together a large vein, which Bardeleben regards as the *vena princeps brachii* and compares with the internal saphena. The external saphena is then homologous with the basilic in the forearm, and the cephalic in the arm is regarded as a downward running branch of the princeps brachii, which is represented in the thigh by a femoro-popliteal vein. This communicates in the popliteal space with the popliteal and internal saphena veins, but this does not explain the course and varieties of the upper part of the cephalic vein which sometimes forms a ring around the clavicle and anastomoses with the external jugular.

Table of Homologies of the Limb Veins.

Thoracic limb.	*Pelvic limb.*
Cephalic, in forearm. Median. Basilic, in arm.	Internal or great saphena.
,, in forearm.	External saphena.
Cephalic, in arm.	Femoral and popliteal.

The homologies of the **Limb Lymphatics** are sufficiently obvious. The superficial and deep lymph vessels correspond in the main, the elbow and popliteal glands respond to each other, except that the latter are more numerous, and the axillary and inguinal glands also answer to each other in receiving the returned lymph from the limb and partly from the trunk.

[1] This is a branch of the superior profunda or profunda brachii, which, however, is not homologous with the profunda femoris.

HOMOLOGIES OF THE LIMB NERVES.

Homologous muscular and skin regions are supplied by homologous nerves, but if nerve plexuses be traced through their nerve fibres and bundles to their nerve trunks and towards the spinal cord, important differences will be found, because the arrangement of these fibres and bundles is different in the two limbs. It is easy to homologise the smaller and peripheral branches, but the larger trunks require some explanation.

The median and internal plantar are homologous, as they correspond in the hand, and the forearm and arm portions of the median are represented in the leg and thigh by the posterior tibial and sciatic. The musculo-spiral is partly homologous with the anterior crural, as they supply, respectively, the extensors of the arm and thigh. On the other hand, the sensitive fibres of the nerve of the leg, which is homologous to those of the ulna, i.e. the posterior tibial, distribute themselves through the posterior tibial and peroneal, and although the latter has a similar relation to the head of the fibula that the ulnar has to the olecranon, yet their further course is quite different, as the peroneal joins the sciatic and the ulnar remains distinct along the whole of the arm. The fibres which are homologous to the palmar branches of the ulnar nerve are represented in the posterior tibial and external plantar.[1]

TABLE OF HOMOLOGOUS (?) LIMB NERVES.

Thoracic limb.	*Pelvic limb.*
Supra-scapular.	Superior gluteal.
Internal cutaneous.	Internal cutaneous and obturator ?
Musculo-cutaneous, in arm.	Sciatic to muscular branches in arm.
,, ,, in forearm.	Internal saphenous.
Circumflex.	Inferior gluteal.
Median in arm.	Sciatic.
,, in forearm.	Posterior tibial.
,, in hand.	Internal plantar. } Of post. tibial.
Ulnar, in hand. }	External ,, }
Middle cutaneous. }	Ext. popliteal.
Musculo-spiral.	Anterior crural.
Radial, in hand.	Musculo-cutaneous, in foot.
Anterior interosseous.	Anterior tibial.

The above condensed account of the limb-homologies represents what is at present held by most anatomists on the subject, but great gaps have yet to be filled in. We are indebted chiefly to the researches of Gegenbaur for laying the foundation of this interesting subject, and after him to Fürbringer[2] and others in Germany; to Huxley, Flower, Humphry, Rolleston, Allen Thomson, Owen, Parker, Goodsir, Turner, Struthers, Cleland, and Macalister in this country; and to Broca, Milne-Edwards, Alix, and Verneau in France. The American anatomists, Agassiz, Coues, Wyman, and Wilder, who have also done good work in this subject, do not agree with some of the views which have been given.[3]

[1] For further details see Ruge, *Morphologisches Jahrbuch*, vol. iv., 1878; also Cunningham's paper quoted in the text.

[2] *Jenaische Zeitschrift*, 1874 (?) Fürbringer's papers have been since separately published.

[3] In this connection a recent paper by Gadow, Gegenbaur's *Morph. Jahrbuch*, 1882, is well worthy of perusal, and doubtless Gegenbaur's forthcoming work on Human Anatomy will contain much valuable information on this and cognate subjects.

SUMMARY OF DISSECTION OF LOWER LIMB.

INGUINO-CRURAL REGION.

1. Make an incision along Poupart's ligament. 2. One from the inner end of this to about half-way down the inner side of the thigh. 3. Reflect the skin.

2. In the superficial fascia find the superficial epigastric, superficial external pudic, and superficial circumflex iliac vessels, and the cutaneous branches of the anterior crural in the mid-line, the ilio-inguinal and genito-crural on the inner side, and the external cutaneous on the outer, and observe the cutaneous veins which empty into the long saphenous. The femoral and inguinal lymphatic glands and vessels must be dissected out.

3. Reflect this layer of fascia, preserving the saphena vein, and note its attachment around the margin of the saphenous opening.

4. Make out the attachments and reflections of the fascia lata as far as exposed and define the structures piercing the cribriform fascia, then reflect the fascia lata by corresponding incisions.

5. Scarpa's triangle will now be exposed ; define its boundaries and contents, which are Poupart's ligament above, adductor longus on the inner side, sartorius on the outer. The femoral vessels in their sheath will be in the middle of the space and the femoral canal on the inner side of the sheath.

6. Open the femoral sheath, and make out the boundaries of the femoral canal, pass the finger up it to feel Gimbernat's ligament on the inner side, and define the fascia transversalis in front and fascia iliaca behind it. Study the branches, anastomoses, and relations of the femoral artery.

7. Trace out the insertions and aponeurosis of the psoas, iliacus, and pectineus, and observe the psoas bursa and the origin of the rectus.

8. Dissect out the branches of the anterior crural and make out the superficial and deep branches of the obturator nerve above and below the adductor brevis.

FRONT OF THE THIGH.

1. From the junction of the outer and inner incisions of the previous dissection make a cut down towards the middle line as far as the tubercle of the patella, and at this point and above, make two transverse cuts on either side and reflect the skin.

2. In the superficial fascia trace out the continuation of the cutaneous nerves, and the internal saphenous nerve and vein, and the radicles of the latter.

3. Reflect the fascia lata, preserving the internal saphenous vein and nerve, and make out its attachments, expansions, and muscular sheaths.

4. Trace out the insertions of the sartorius, rectus, adductor longus, vasti, and tensor fasciæ.

5. Follow out the muscular and cutaneous branches of the anterior crural; define Hunter's canal, and observe the relations of the femoral artery, vein, and internal saphena nerve within it. Trace out the branches and anastomoses of the superficial femoral and the branch from the obturator nerve to the knee, also the mid-femoral plexus and nerves.

6. Dissect out the course, branches, and relations of the profunda artery and its venæ comites.

7. Reflect the adductor brevis and note the deep branch of the obturator nerve and the muscles it supplies. Trace out the insertions of the pectineus, psoas, and iliacus, and the origins of the crureus and vasti, and insertions of the adductor magnus. Reflect the crureus by a transverse incision about four inches above the patella, so as to carefully expose the subcrureus, then make out the reflected tendon of the rectus. Observe the insertion of the subcrureus into the synovial membrane.

GLUTEAL REGION.

1. Make an incision from the tip of the coccyx along the sacral spines and iliac crest to the anterior superior spine, and one from the coccyx along the gluteal fold to the great trochanter. Reflect the skin outwards.

2. In the superficial cellulo-fatty layer, find branches from the lumbar nerves along the iliac crest, and branches from the sacral plexus and from the small sciatic at the inner and lower parts.

3. Reflect this layer by similar incisions, and expose the gluteus maximus and medius invested by their fasciæ. Note the aponeurosis of the gluteus maximus, and that of the medius which is much stronger. These are formed by the deep fascia, the attachments of which have been given in the text. Reflect the deep fascia.

4. Make out the attachments and action of the gluteus maximus and reflect it, being careful of the vessels and nerves which supply it and of the others beneath it.

5. Note the structures covered by the gluteus maximus and dissect them out, namely, the sciatic vessels and nerves, the internal pudic vessels and nerve, and nerve to the obturator internus and pyriformis. Observe also the great sacro-sciatic ligament and the perinæal branch of the small sciatic nerve, also the origins of the hamstring muscles from the tuber ischii. A bursa will be found between the tuber and the hamstrings, between the insertions of the gluteus maximus and the great trochanter, and sometimes another between it and the origin of the vastus externus.

6. Dissect out the structures leaving the pelvis above and below the pyriformis, and define the attachments of the gluteus medius and minimus and insertions of the pyriformis.

7. The insertion of the obturator internus and the attachments of the gemelli and quadratus femoris should be made out.

8. Define the tendon of the obturator externus, and observe a branch of the internal circumflex coming up towards the back of the thigh.

9. Trace out the internal pudic artery and some of its branches, and define the lesser sacro-sciatic ligament.

10. Dissect the ligaments of the hip joint, noting its motions and relations, and observe if the psoas bursa communicate with it; open the joint and study its bony and cartilaginous formation.

BACK OF THE THIGH.

1. Make an incision along the middle of the thigh to just below the popliteal space, and transverse ones at either end of this on the outer and inner sides, and reflect the skin.
2. In the superficial fascia notice the branches of the cutaneous nerves of the sciatics and posterior of crural, trace out any of the larger veins adjoining the internal saphenous, and follow the external saphenous vein through the deep fascia.
3. Reflect this fascia by similar incisions so as to expose the fascia lata, of which observe its expansion over the popliteal space.
4. Reflect the deep fascia, noting its muscular sheaths and outer and inner intermuscular septa.
5. Trace out the boundaries and contents of the popliteal space and follow the hamstrings to their insertions.
6. Trace out the sciatic nerves and their branches, and the division of the greater into the internal and external popliteal.
7. Follow out the perforating branches of the profunda, and note their distribution and anastomoses.
8. Define the insertion of the adductor magnus, noting the way in which the femoral vessels pierce it, and make clear the short head of the biceps.

POPLITEAL REGION.

1. Trace out the branches of distribution and anastomoses of the popliteal artery, and its relation to the popliteal vein and nerves.
2. Note the external saphenous vein and other veins which empty into the popliteal vein.
3. Define the boundaries of the space which are above the joint; on the inner side, semitendinosus, semimembranosus, adductor magnus, and gracilis; above the joint on the outer side the biceps; below the joint on the inner side the inner head of the gastrocnemius; on the outer side below the joint is the outer head of the gastrocnemius and plantaris.
4. Trace out the muscular, articular, and cutaneous branches of the popliteal nerves, and define the posterior ligament of the knee, noting the expansions of the semimembranosus.
5. Dissect out the anastomoses of the articular arteries.

THE FRONT OF THE LEG.

1. Continue the median incision to just below the ankle joint, making transverse cuts above and below on either side, and reflect the skin.
2. In the superficial layer observe the patellar plexus of nerves, the prepatellar bursa, and the branches of the internal saphenous nerve on the

inner side accompanying the vein, and of the external popliteal on the outer side. The subcutaneous bursa over the insertion of the ligamentum patellæ should be made out. The insertions of the inner hamstrings and the inferior articular arteries must be defined.

3. Reflect this layer and expose the deep fascia, and note its attachments, observing the musculo-cutaneous nerve piercing it at the lower part, which must be preserved. The two portions of the anterior annular ligament must be defined and preserved.

4. Reflect the deep fascia, noting its processes and preserving the anterior annular ligament. Some of the muscles will be found to arise from the deep surface of the fascia at the upper part of the leg.

5. Make out the origins of the tibialis anticus, extensor proprius pollicis, extensor communis digitorum, peroneus tertius, and peroneus longus and brevis, and follow out the musculo-cutaneous nerve to its origin.

6. Trace out the anterior tibial artery and peroneal vessels, the anterior tibial nerve, and at the upper part the recurrent nerve to the knee joint.

7. Note the attachment of the interosseous membrane, and its relations to the tibia and fibula.

DORSUM OF THE FOOT.

1. Continue the median incision to the nail of the little toe, and make transverse cuts on either side at the webs of the toes, and reflect the skin.

2. In the very thin superficial fascia observe the veins forming an irregular arch, from which on the inner side the internal and on the outer the external saphena veins arise. Trace the branches of the musculo-cutaneous and internal and external saphenous nerves to their respective toes.

3. Observe the relations of the tendons passing beneath the anterior annular ligament, and note their synovial sheaths. The tendons of the peronei, the ligament binding them down, and their synovial sheaths, should also be observed.

4. The anterior tibial vessels and nerves passing beneath the annular ligament, and their relative positions with their outer and inner malleolar branches, must be made out, and the dorsalis pedis and its branches traced after reflecting the deeper fascia which also invests the dorsal interossei.

5. After tracing out the tarsal, metatarsal, interosseous, and digital arteries, and the origins and insertions of the extensor brevis digitorum, they may be reflected and the attachments of the dorsal interossei made out.

6. The skin should be reflected from the other toes, and the mode of insertion of the tendons of the extensors and their processes should be clearly defined. This may be facilitated by dividing the tendons above the annular ligament and pulling them downwards.

7. Define the dorsal ligaments of the ankle, foot, and phalanges.

BACK OF THE LEG.

1. Continue the median incision to the bottom of the heel, making transverse ones at its lower extremity. Reflect the skin in and out.

2. In the subcutaneous fascia make out the external saphena vein and

nerve in the mid-line, and their branches, also the posterior cutaneous twigs of the internal saphena nerve.

3. Reflect the aponeurosis by similar incisions, preserve the saphena vein and nerves, which must be dissected out.

4. The deep fascia is then exposed. Notice its attachments to the tibia and fibula, and its strengthening process at the inner and outer side of the ankle, also its continuation with the popliteal fascia above. Preserve the vessels and nerves piercing it.

5. Reflect the fascia near the gastrocnemius, and the tendon of the plantaris will be exposed. Follow the tendo-Achillis to its insertion, and note the bursa between it and the os calcis.

6. Reflect the gastrocnemius, when the soleus will be exposed. Note its two processes of origin, and its insertion into the tendo-Achillis. Reflect the soleus to expose the deep fascia separating the superficial from the deep muscles.

7. Reflect this fascia, dissect out the posterior tibial artery and veins, posterior tibial nerve, and the peroneal artery and vein.

8. Define the origins of the flexor longus hallucis, tibialis posticus, flexor communis digitorum, and peronei.

9. Either pull these muscles aside, or divide their tendons to expose the interosseous membrane and define the attachments and relations of the latter.

10. Trace out the tendons and synovial sheaths of the tibialis anticus, flexor longus digitorum, and flexor longus hallucis behind the internal malleolus and beneath the internal annular ligament.

11. Follow out the structures, passing across and around the ankle joint, and define their relative positions.

12. The knee joint and its internal and external articular ligaments and joint surfaces must now be dissected, also the tibial and fibular ligaments.

PLANTAR REGION.

1. Continue the median incision to the end of the middle toe.

2. Make transverse ones on the outer and inner side along the webs of the toes

3. Notice the plantar cutaneous branches of the posterior tibial and plantar nerves, the cutaneous branches of the plantar arteries, and the calcanean branch of the posterior tibial.

4. Define and dissect the three processes and digital prolongations of the plantar fascia. Be careful of the digital vessels and nerves near the webs of the toes, also of the cutaneous branches of the plantar arteries and nerves.

5. Open each process of the plantar fascia and observe the partitions from the outer and inner side of its median portion forming the three compartments in the sole.

6. Dissect out the attachments of the superficial muscles and study their actions.

7. Reflect the superficial muscles to expose the flexor communis digitorum, flexor accessorius, flexor longus hallucis, and lumbricales, and follow out the internal and external plantar vessels and nerves.

8. Reflect this layer of muscles to expose the adductor pollicis, transversus pedis, flexor brevis hallucis, and flexor brevis minimi digiti, and study their actions and relations.

9. Follow out the branches of the plantar arch and the muscular and articular twigs of the nerves.

10. Reflect these muscles, and follow out the sheaths and tendons of the peroneus longus and tibialis posticus. Define the plantar interossei, noting their insertions.

11. Define the ligaments of the sole, and dissect out the articulations of the ankle, tarsal bones, and phalanges.

VARIETIES OF BONES OF THE PELVIC GIRDLE.

Os Coxæ, or Innominatum.—Beneath the anterior superior spine there is occasionally a small rough surface, the *supra-cotyloid tubercle*, and there is occasionally a curved line passing from the anterior inferior spine to the middle of the great sciatic notch which marks off the lower limit of the region of the gluteus minimus; this is the *linea arcuata externa inferior*. Sometimes a linea arcuata extends from the posterior inferior spine perpendicularly upwards to the external lip of the crest. It defines the region of the gluteus maximus from that of the medius. An *ilio-pectineal* or *pubic tubercle* is often present at the anterior end of the pubic crest behind the tuberculum pubis. Frequently an *ilio-pectineal spine* is found behind the ilio-pectineal tubercle, and the psoas minor is inserted into it. The external iliac artery and vein pass between this muscle and the ilio-pectineal tubercle. At the junction of the pubic and ischiatic rami there is sometimes a roughish line, termed the *pubo-ischiatic ridge*, or *eminence*, and at this place the inner borders of the rami are sometimes raised, forming a *crista penis seu clitoridis*. The inner and outer boundaries of the obturator foramen at their upper and inner parts sometimes have slight bony ridges or projections, termed the superior or internal, and inferior or external, *obturator tubercles*, respectively. From the superior obturator tubercle a line runs back to the ischiatic spine on the inner surface of the ischium. Rarely, there is an *accessory ischial spine*, from which an external ligament, the *superior spino-sacral*, passes to the ordinary spino-sacral ligament and forms with it a *third sciatic notch*, or *foramen*. This spine, when present, is situated at the junction of the ilium and ischium.

Pelvis.—Slight want of symmetry of the two sides is common, as lateral asymmetry is characteristic of the higher groups of animals. The left half is somewhat wider, more round, and its curvature is smoother and belongs more to its anterior portion, whilst the left part of the sacrum is shorter. These differences coincide with the greater development of the right arm and the corresponding compensatory lateral curvature of the dorsal vertebræ, which are concave to the right, and of the lumbar vertebræ, which are concave to the left. There is frequently a *pre-auricular sulcus* which runs from the anterior edge of the sacro-iliac joint, and is especially frequent, according to Zaaijer, in Javanese women. The anterior sacro-iliac ligament is attached to it. The pelvic deformities due to rickets and mollities ossium being pathological, need not here be noticed, but it may be mentioned that in about 15 per cent. of the whole the conjugate pelvic diameter is short enough to cause difficulty in parturition.

Femur.—The length and obliquity of the neck varies in individuals and at different ages. In powerful muscular subjects there is commonly

a *superior tubercle* of the femoral neck placed at the upper end of the anterior intertrochanteric line, and in the middle of this line an *inferior tubercle*, which latter, according to Williams, indicates the limit between the origins of the vastus internus and crureus. The limit between the anterior and posterior surfaces is not uncommonly more pronounced than usual, and springs from just below and anterior to the trochanter minor, and is continuous above with the anterior intertrochanteric line. In about half the cases there is a *supra-condyloid process* or *tubercle* at the posterior part of the internal condyle, and the inner head of the gastrocnemius arises from it. This process has been found, though rarely, of two centimetres in length, and is separated from the internal condyle by a smooth depression which has been called the *supra-condyloid fossa*. Sometimes a corresponding tubercle at the upper end of the external condyle is present, and the plantaris arises from it; and above this latter tubercle, or about the situation of the bifurcation of the linea aspera, a process three centimetres long and nine millimetres thick has been observed. This has been termed the *third trochanter*, and when not pathological may be considered homologous to the humeral supra-condyloid process. In the femur of an elderly woman I saw a bony projection about the size of a shilling, and raised nearly half an inch from the bone surface. This was situated about half an inch below the great trochanter, about the middle of the outer aspect of the bone. It did not appear to be pathological, and if it could be shown to occur in a certain percentage of cases, would better deserve the term third trochanter than the process at the lower end just mentioned. As a rule, on each condyle there is a flat impression or groove (pressure facets) which begins at the intercondyloid fossa and passes laterally out, becoming broader. It is more frequent and pronounced on the inner condyle. These are produced by the pressure of the anterior edges of the semilunar fibro-cartilages during complete extension. The tibial surfaces of these condyles are separated from the patellar surface through a more or less developed ridge which crosses anterior to the pressure facets. Mikulicz states that frequently a groove, uncovered by cartilage, runs between the lateral edges of the patellar surface and the remaining part of the external condyle, which, being distinct from the lateral pressure facets, he thinks, may be pathological; but its frequent occurrence is, in my opinion, against this view.

Tibia.—The outer edge of the upper articular surface of the external tuberosity, as well as the inner edge of the internal, are often separated from the rest of the articular surface by circular lines. The parts external to this line correspond to the fibro-cartilages, and the parts internal to the femoral condyles. Corresponding differences are present in the femoral condyles. A rough surface on the antero-lateral part of the external tuberosity into which the ilio-tibial band or ligament of the fascia lata is inserted has been called the *tuberculum tibiæ*. At the inner sides of the tubercle and at the lower end of the tibia there occur, though rarely, the *superior* and *inferior trochlear processes*. The tendon of the gracilis or semimembranosus passes beneath the upper one, and the tendons of the tibialis posticus and flexor hallucis longus beneath the lower one. In rickety subjects I have often observed the superior process, especially in cases of knock-knee, and it seems probable that it may be produced by overgrowth at the epiphysial line through irritation produced by the

stretching of the internal lateral ligament, or it may be an ordinary exostosis. The process is only present in a comparatively small proportion of rickety knock-knees; sometimes only on one side, but often on both.

Fibula.—On the lateral surface of the head there is often a small tubercle which gives origin to the peroneus longus, and about the middle of its posterior surface is another from which the soleus partly arises. Sometimes the ridge on the posterior part of the lower end is unusually raised. Its anterior surface has frequently a prominent transverse ridge called the *tuberosity of the fibula.* This divides it into an upper, smaller, lower, and much larger division. The facets on its articular surfaces have been described in giving the anatomy of the knee and ankle joints.

Tarsal Bones.—*Astragalus.* The anterior facet is often divided into two by an elevated ridge, but in 50 per cent. of the cases the ridge is absent and the two coalesce. This facet may be entirely absent in about 7 per cent.; and when present, as is usual, there may, in about 16 per cent. of the cases, be an additional groove which has been termed the *accessory interarticular sulcus.* Its lateral tubercle may be enlarged, forming a *processus trochlearis,* and in 2 per cent. this tubercle is separate, forming an eighth tarsal bone or secondary astragalus. Rarely, a similar process is found on the inner side of the neck bone.

Os calcis.—On the outer surface, under the lateral edge of the postero-lateral articular surface, there is found, in 39 per cent., an oblique ridge called the *calcanean,* or *infra-malleolar process.* Beneath this runs the tendon of the peroneus longus. The articular surfaces correspond to those of the astragalus, just described, and may coalesce or be absent, as in the former bone. The interosseous sulcus, when present in the calcis, has been termed the *accessory interarticular sulcus* of the calcaneum. It forms, with the similarly named groove of the astragalus, a canal which runs forwards and inwards to the *sinus tarsi.* In one instance, recorded by Stieda, a small secondary calcaneus was present.

Scaphoid.—Rarely, at the posterior end of the dorsal surface of this bone there exists a *trochlear process,* beneath which the tendon of the extensor hallucis passes. The scaphoid tuberosity has in about 10 per cent. of the cases at its posterior part a *process of the navicular tuberosity,* and very seldom does this become isolated to articulate as an accessory navicular with the tuberosity. The passage of the lower into the lateral surface of this bone occurs in about 76 per cent. of the cases, and takes place at an angle termed the *navicular angle,* which may form a projection or point called the *navicular spine.*

Internal Cuneiform.—This is in rare instances doubled, forming a dorsal and plantar cuneiform.

Cuboid Bone.—A more or less pronounced prominence on the inner angle of the posterior surface sometimes exists, and has been called the *styloid process* of the cuboid. It may be doubled according to Blandin.

Supernumerary and Sesamoid Bones.—Sometimes these are found on the dorsal surface between the tarsal and metatarsal bones. The most common occurrence is to find an ossiculum intermetatarsium in the joint capsule between the internal cuneiform and first metatarsal, on their external aspects. It is often cartilaginous. There are usually four sesamoid bones, which are contained in synovial capsules or enclosed in bursæ; the

two largest lie on each side of the plantar surface of the head of the first metatarsal, and are firmly attached to the transverse plantar ligament, and through this and accessory bands are closely united with the first phalanx of the great toe. The fourth sesamoid is found near the outer end of the cuboid tuberosity in the tendon of the peroneus longus, and frequently a fifth is present at the inner end of the head of the astragalus, and a sixth is occasionally found on the inner surface of the internal cuneiform. But instead of the sesamoid bones only fibro-cartilage may be present.

DISSECTION OF THE PERINÆUM.

The owner of the *abdomen* must begin his part by dissecting this region, which is usually allotted with it. The perinæum is generally dissected on the first day, and begun early, so as not to interfere with the progress of the other dissectors, and also because if the parts be not examined soon they lose their distinctness. Its dissection must be completed on the first day or two.

Directions.—Place the body on its back, introduce a metal catheter into the bladder, and tie it in with a loop of string, which should pass from the penis to the handle of the staff or catheter. Draw the buttocks quite to the edge of the table, and if necessary, raise the pelvis by a small hollow block placed beneath the buttocks; bend the thighs on the trunk and the legs on the thighs, and abduct the latter so as to put the perinæum on the stretch. To keep the parts in this position, put the apparatus shown in the figure between the thighs, and fasten it on. By

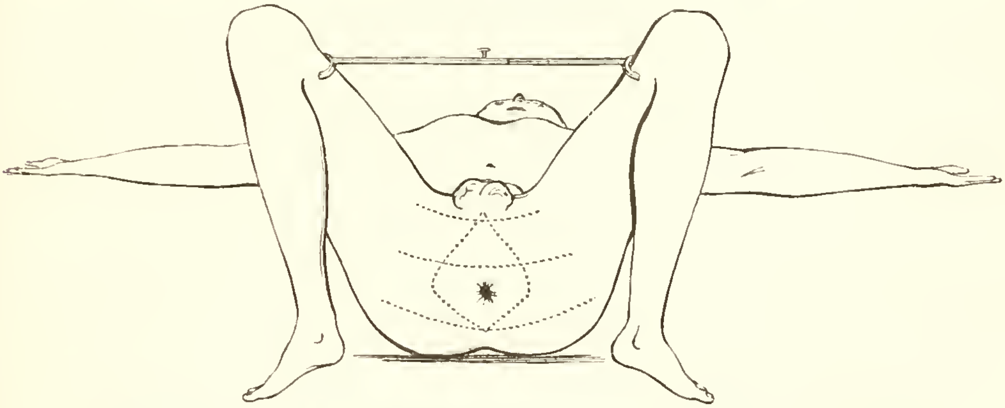


FIG. 459.—DIAGRAM OF INCISIONS FOR DISSECTING THE PERINÆUM.

The instrument for keeping the legs apart is in position.

it the knees can be approximated or separated to suit the convenience of the dissector.

Should this simple, convenient, and useful apparatus not be in the dissecting room, the limbs may be secured in the necessary position thus. After having bent the limbs as directed, pass a stout long cord twice round one knee, then under the table and around the other, and before fastening it off to the opposite knee, place a light block of wood between them. Another method of fixing the limbs in the required position is by having upright spokes fitted to the sides of the dissecting table, to or over and round which the knees are fastened by a rope. These methods are superior to that of tying the hands and feet together as is usually done—after the manner adopted before the operation of lithotomy—because they

do not interfere with the dissection of the arms and head and neck, therefore the possessors of these can go on with their parts. After carrying out the instructions in the following paragraphs, the student should pass a stitch through the lower part of the *scrotum* and fasten it to the skin of the abdomen, but if the subject have been preserved in salt this may not be necessary, as the scrotum will have shrunk.

Practical Surgery.—In introducing the staff, sound, or catheter the student most likely met with some difficulty, so a few words explanatory of the usual difficulties, and some directions to avoid them, will be of service to him, and he must always bear them in mind when attempting to introduce an instrument on the living.

How to pass a Catheter.—Get a medium-sized catheter or bougie, rub it with a clean towel or handkerchief to clean and warm it, oil it well, and stand at the left side of the subject, with the instrument in the right hand and the penis in the left (the student should practise all operations with both hands, so as to acquire ambi-dexterity). Now introduce the end of the instrument into the external meatus, and draw the penis over the catheter, which is to be gently pushed on with its end touching the upper aspect of the urethra, and kept steadily in the middle line. If a slight hitch be felt when the instrument has travelled about four and a half inches in the adult, withdraw it slightly and try again. This hitch generally occurs at the *triangular ligament*, so called. When it has been passed about four to five inches, depress the handle between the thighs, at the same time gently urging it on into the bladder. The left index finger, introduced into the rectum, will tell the student if the instrument be in the middle line, and will be useful in guiding it into the right direction. These directions apply to passing the instrument in the supine as well as in the erect position of the body, except that in the latter the handle need not be so much depressed. Should there be a small quantity of urine in the bladder, as is usually the case *post mortem*, it will run out of the instrument, should the latter be pervious. If the urine be prevented from escaping, the catheter can be rotated in the bladder, but if the bladder be contracted, the end of the instrument will rub against its muscular walls, and impart a feeling of *soft roughness* to the hand. If the coats of the bladder are encrusted with phosphates, a *grating* sound will be elicited, and if one or more stones be in the viscus, a distinct ringing, clicking, or roughened sound will be given out by bringing the instrument *quickly* into contact with them. These manœuvres are adopted in

Sounding for stone in the bladder.—To the inexperienced, there are certain sources of fallacy in sounding for stone, due to the bony surroundings of the bladder, met with especially in children. The student may become familiar with these by adopting the following manœuvres. The sound being well in the bladder and the handle depressed between the thighs, draw the sound forward and it will come in contact with the back of the symphysis pubis; then push the sound straight backwards and the anterior aspect of the *sacrum* with its promontory will be struck. At the sides of the bladder, *the spines of the ischia* may be felt. The feel and sound of these bony parts, touched with the bladder coats between them and the sound, are of a *dead* character, and very different to those of a *calculus*. It is more difficult to introduce an instrument in the *cadaver* than in the living subject, because the urethra in the former is relaxed,

and is deficient in the normal mucous secretion of the part, and also because of the *rigor mortis* affecting the muscular fibres surrounding the urethra. If some time, varying generally speaking from two to five days, have elapsed since the time of death, this condition will have passed off. Should one or more *strictures of the urethra* be present, it will be very difficult and perhaps impossible to get the instrument in. Enlarged prostate also increases the difficulty of passing an instrument with the ordinary curve, and a prostatic catheter, which has a much larger curve, has to be used. As many dissecting-room subjects are old men, this condition may be present in the body being dissected. In the *female* the urethra is only about three-quarters of an inch long, a female catheter can easily be passed, and if necessary the urethra dilated and the bladder explored by inserting the little finger guided on a probe which is previously introduced. Subsequently an instrument called the cysto-urethroscope, which I have devised, can be introduced, and the urethra and bladder explored. The index finger introduced into the bladder may afford valuable information in the diagnosis of tumours of the womb, ovaries, &c.

Directions.—Inject with a syringe a pint and a half of water through the catheter into the bladder, and put a plug into the outer end of the instrument.

How to examine the rectum.—Put some soap, lard, or tallow under and around the nail to prevent its retaining any fæces, oil the finger, and pass it into the rectum. The catheter will be felt in the middle line. About an inch up, the circular internal sphincter muscle may be felt, and in the living subject it forms a tight ring. On the *anterior wall*, about *three inches up*, is a transverse fold of mucous membrane which is constant, and forms the first impediment to the passage of a bougie or enema tube. This fold corresponds to the upper border of the *prostate* and lower end of the *trigone vesicale.* It is here that the bladder is tapped *per rectum* in cases of retention of urine from any cause. While the finger is on this spot, with the other hand press the lower part of the abdomen, and recognise the condition and feel of the moderately distended bladder. When it is much distended it imparts a tense semi-elastic feel. The base or upper border of the *prostate gland*, which is three-quarters of an inch broad, corresponds to the transverse fold just mentioned, and an inch and a quarter nearer the *anus* is its apex. In front of this is the membranous portion of the urethra, which is about three-quarters of an inch long, and just in front of this the *bulb* of the *corpus spongiosum* may perhaps be felt. In children the prostate gland is small, and the membranous urethra relatively long. Its walls are very thin, and it is more curved because the bladder is in them more in the abdomen than in the pelvis. Now pass the finger again upwards and make out the apex, lateral lobes, and base of the prostate, just above the latter is the apex of the *trigone vesicale*, immediately behind which the *trocar* is introduced in tapping the bladder *per rectum.* The *recto-vesical* fold of the peritoneum is usually four inches from the anus, and cannot be reached unless the finger be long. This fold is said to descend lower in children and negroes. Through the *posterior* wall the lower part of the anterior surface of the sacrum and the whole of the coccyx may be felt, and laterally the soft structures of the *ischio-rectal fossæ* may be recognised. It must be borne in mind that the walls of the rectum are, in a state of rest, in contact like those of other mucous

canals which do not run through bony or cartilaginous cavities. In the *female* the *vagina* and *uterus* separate the urethra and bladder from the rectum, but the cervix and posterior aspect of the body of the uterus can be felt through the anterior rectal wall. By passing the index finger into the rectum and putting the thumb on the skin over the coccyx, any fracture, displacement, or growth connected with this bone may be made out. The student should percuss in the middle line above the pubes, so as to become familiar with the dull sound of a distended bladder, and he may then allow the water to run out of the catheter by depressing it and removing the plug. An ordinary rectal *speculum* may now be introduced, but a much better view can be obtained by using the expanding one that I have had constructed. Whichever be used, it should be warmed and oiled, and the narrow end placed within the *anus*; then push it gently but firmly first upward and forward, then upward and backward, following the curve of the sacrum. If good daylight be not available, the light from a candle will suffice to note the condition of the mucous membrane, which is much paler than in the living. Notice its longitudinal folds, and if there be internal piles (a common condition) the student will see bluish or purplish prominences. The instrument should be rotated so that the *fenestrum* or slit may alternately expose all parts of the mucous membrane.

A rectum *bougie* or ordinary tallow candle, bent to the curve of the sacrum, should now be carefully passed eight or ten inches. It may be obstructed at either of the three transverse folds of mucous membrane, the first of which has already been mentioned. The second is on the left side, about five and a half inches from the anus, and the last on the right, eight inches up, viz. at the upper limit of the rectum. The first fold is constant, one or both of the others may be absent.

A small hand, not more than nine inches in circumference, may be passed into the rectum and sigmoid flexures, and valuable information regarding abdominal and pelvic tumours may thus be obtained, but this must be done very carefully for fear of tearing the bowel or its peritoneal covering.

Surface and deep guides and limits.—The *perinæum* is the name given to the soft parts which close, like a diaphragm, the outlet of the pelvis. This partition is pierced by the genito-urinary organs and rectum, and, in the erect position, forms a groove between the buttocks. In the *male* this region extends, on the surface, from the back of the scrotum in front to the apex of the coccyx behind, and is bounded laterally by the thighs and posteriorly by the buttocks. Its shape is rather that of an inverted *ace of hearts*, than lozenge-shaped, and the anterior portion, which inclines down and back, meets the posterior, which slopes up and back, at an imaginary line joining the fronts of the tubera ischii. The projection of the anterior space is due to the prominence of the urethral bulb and corpus spongiosum. In a dried pelvis, prepared with only the bones and ligaments, the shape is somewhat like a lozenge or ace of diamonds.

The skin is brownish and covered with hairs, which surround the anus, and in the adult male usually extend to the coccyx, but not in the female. In the middle line, over the urethra, where the surface is more convex and slopes, slightly hollowed, to the sides, is a darkish line or raphé, which extends from the front of the anus, along the middle of the *scrotum* and under the surface of the penis to the *frænum preputii*. A median line, ridge,

or raphé is found on the anterior and posterior surfaces of the body, and represents the junction of the two lateral portions of the embryo. This central raphé divides this area longitudinally, and is, as Mr. Holden says, 'the line of safety' in making incisions to let out matter or effused urine, or to divide a stricture of the urethra from without.

Directions.—The student should handle the *testes* and *spermatic cords*, so as to become familiar with their feel. These parts are less firm than in the living. He should also pass his little finger along the cords into the inguinal canals, and should observe the wrinkled condition of the *scrotum* due to the muscular fibres of the *dartos*.

In the posterior portion of this space, observe the aperture of the rectum called the *anus*, in the middle line, and note the wrinkled condition at its margin, due in the living, to the contraction of the *external sphincter* and *corrugator cutis* muscles. These radiating folds are generally obliterated on the subject which is being dissected by the position of the body and the distension of the rectum. Observe, with a hand magnifier, the openings of the sebaceous follicles and sudoriparous *glands* around the

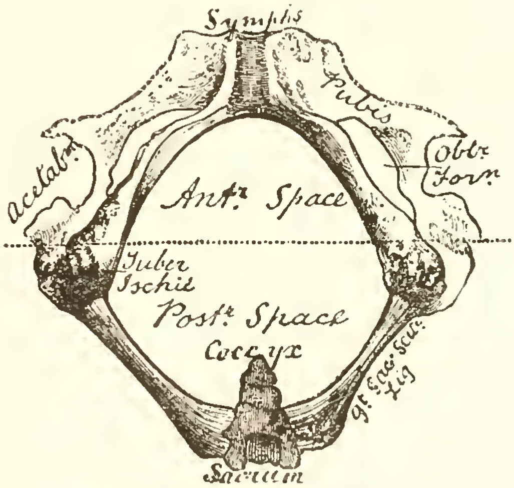


FIG. 460.—OUTLET OF PELVIS SHOWING DIVISIONS OF THE PERINÆAL REGION.

anal margin. These sometimes inflame and suppurate, and may be mistaken by the inexperienced for the openings of rectal fistulæ. A few dilated veins may perhaps be seen at the rectal aperture forming external piles. If the finger be firmly pressed on each side of the rectum it will sink into the ischio-rectal fossæ.

The **Perinæal region** [1] is artificially divided into two so-called triangles, by an imaginary line passing from the front of one *tuber ischii* to the other. The anterior one is the *genito-urinary space*, or *urethral triangle* of some authors; the posterior is the *anal triangle*, or more properly the *ano-rectal space*, as it contains the lower part of the rectum, its vessels and nerves, and the muscles which act on the anus. These names sufficiently indicate the contents of the respective spaces, and the student will note that here are situated the two great excretory outlets of the body; in the *anterior* is the *urinary* passage, the urethra; in the *posterior* is the

[1] Certain well-defined parts of the body are termed *regions*, but the student must bear in mind that as the various structures of the body are more or less continuous, the name is to a large extent an arbitrary one.

canal for the *fæces*, the rectum. In the female there is a third passage between these; it is the uterine inlet and outlet, and is called the *vagina*.

Practical Surgery.—Pass the oiled finger into the vagina, and feel the os and *cervix uteri*. The urethra and part of the lower portion of the bladder may be felt through the anterior wall, and the rectum through the posterior. The student should introduce the uterine speculum, following the curve of the sacrum, and get a good view of the os uteri; he should also introduce the *uterine sound*.

Boundaries.—The dissector should have by him a pelvis with the ligaments preserved, so as to compare the deep boundaries where covered by the soft parts, with the same structures in the prepared or dry state. This should be placed in the same position as that of the subject, and it will be seen that this region corresponds with the outlet of the pelvis, which is larger in the female, but individual differences in the size of the aperture between the tubera ischii and the rami of the pubes will be found in both sexes; and diseases like rickets and mollities ossium may considerably contract the pelvic outlet, so as to render the extraction of a fœtus or of a large calculus a matter of great risk and difficulty.

In front, the perinæum (this is the collective term for the whole space, but in strictness the *perinæum proper* only extends from the anus to the back of the scrotum in the male, and in the female between the anus and the *posterior fourchette* of the *vulva*) is bounded by the symphysis pubis and subpubic ligament; *laterally*, by the descending rami of pubes, covered by the *crus* and *erector penis*, and by the tubera ischii. These are the boundaries of the *anterior triangle*, which is nearly equilateral, and its sides are from three to three and a half inches long.

The *posterior portion* is smaller, and is bounded *behind* by the coccyx and at the *sides* by the inferior borders of the great gluteal muscles and the great sacro-ischiatic ligaments, which are under cover and a little external to the gluteal margins. The *floor* is formed by the recto-vesical portion of the pelvic fascia, which cannot yet be made out as it is at the pelvic outlet, but the student should *feel* the other structures enumerated.

The perinæum measures about four and a half inches from before back, and three inches between the ischial tuberosities, and is about an inch deep near the pubes and about three inches at either side of the anus, but these measurements are subject to individual variations, and are of course much less in children.

Directions.—Before reflecting the skin, chalk out on the surface the position and course of the vessels and nerves, and the situations of the penile bulb and triangular ligament, following the figures of the structures given later on. The following parts, which can be made out in a moderately thin subject, should also be felt.

Midway between the centre of the anus and the back of the scrotum, or about two inches in front of the anus, is placed the so-called *central tendon* of the perinæum, where the perinæal muscles meet.

A little above this is always placed the penile bulb, and the artery to it; therefore the incision in lateral lithotomy should never be begun above it.

In fat people the bulb cannot be made out from the surface. When holding the staff during the operation of perinæal lithotomy, the penis

should be pulled well up on the instrument, so as to drag the bulb up and out of the way.

Passing back and up from this point is the membranous part of the urethra, just in front of the prostate, and $1\frac{1}{4}$ inch further on is the neck of the bladder, which is generally between three and four inches from the surface.

The lower or posterior border of the deep perinæal fascia or triangular ligament can be felt just behind the bulb. By drawing the anal margins apart, a whitish line, marking the junction of skin and mucous membrane, and corresponding to the separation of the external sphincter from the lower border of the internal sphincter, can be seen.

THE ISCHIO- OR ANO-RECTAL SPACE.

Dissection.—The incisions for the dissection of the perinæum may vary. The usual mode is the following, but the figure represents another plan which is described below. Make three transverse incisions through the skin, one just in front of the anus, joining the ischial tuberosities, one above it, at the root of the scrotum, and the third just behind the tip of the coccyx. These should extend the same distance laterally. The incision at the root of the scrotum need not be made till this region is finished. These transverse incisions are to be joined by a vertical one, extending from the root of the scrotum to beyond the coccyx, and skirting the anal margins.

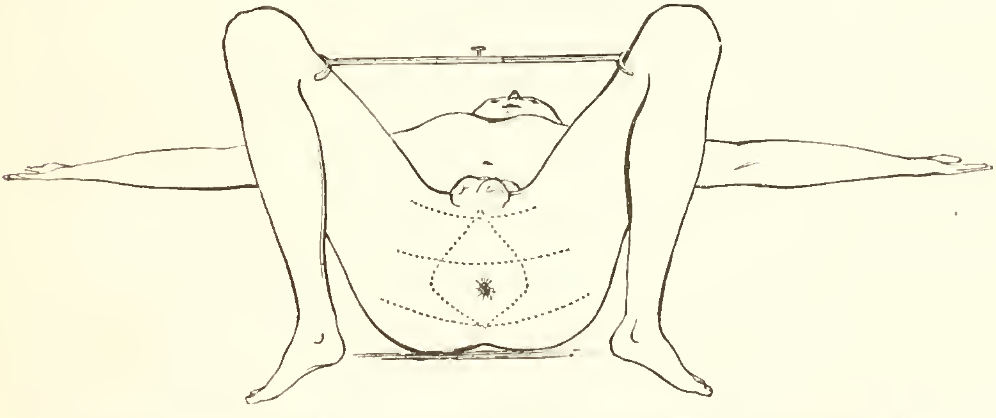


FIG. 461.—DIAGRAM OF INCISIONS FOR DISSECTING THE PERINÆUM.

The instrument for keeping the legs apart is in position.

Another method is to make the incisions correspond to the perinæal boundaries, viz. just outside the rami of pubes and ischium, and beyond the margins of the great glutei. The angles should be rounded and the scrotal portion truncated. If the former plan be adopted, the skin is to be reflected from the middle line outwards, but in the second case from without inwards or from above downwards, and then removed.

In the second method, the two divisions of the perinæum may be dissected separately—as in the former—by making a transverse incision in front of the anus to meet the lateral ones.

The skin around the anus must be carefully removed to avoid injuring the corrugator and external sphincter, which are immediately beneath it. In doing this it will be observed that the skin is very thin and merges gradually into the mucous membrane of the rectum. This portion of the skin is well supplied with minute sebaceous glands, called the *anal glands.*

The *subcutaneous tissue or fascia* of this region is continuous with that of the buttocks, thighs, and scrotum, and contains fat, except over the corrugator and external sphincter. The quantity of this fat varies in individuals, and if in abundance, it increases the depth of the perinæum, and of course that of the incision in lithotomy. It also, as Professor Quekett pointed out, contains anal glands and some involuntary muscular fibres. Some cutaneous vessels and some filaments of nerves from the internal pudic and small sciatic perforate this layer and supply it and the skin. The fat in the deeper layers is continuous with that in the ischio-

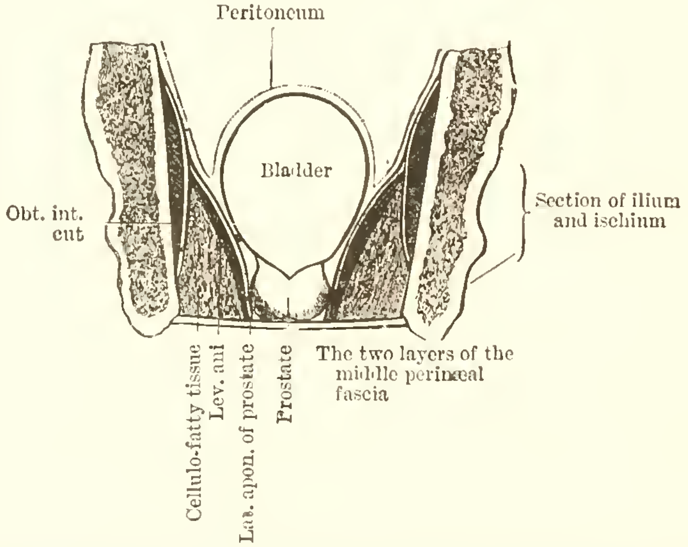


FIG. 162.—DIAGRAM OF VERTICAL TRANSVERSE SECTION THROUGH THE PELVIS PASSING ACROSS THE BLADDER AND PROSTATE.

rectal fossæ, as will be seen in cleaning these spaces, which should now be done.

The *Cutaneous Vessels and Nerves* of both spaces come from branches of the internal pudic artery and nerve, and from the inferior or long pudendal nerve.

Directions.—To define the boundaries of the ischio-rectal fossa, the dissector should begin at the outer margin of the external sphincter, and proceed outwards. On one side he should seek the vessels and nerves, but on the other he must disregard them, so as completely to expose the muscles which limit it. As he removes the coarse granular fat, he will note that it is enclosed between layers of fascia, and that it thoroughly fills the spaces on each side of the lower part of the rectum. Its use is to support and protect the rectum and its vessels and nerves, which otherwise would hang free, also to allow of its distension without injury. The elasticity of the tissue in which the fat is contained permits of its returning to its original condition after the rectum has been distended, and thus

assists that organ in its contraction. Were it not for this accumulation of fat there would exist two deep hollows on either side of the rectum which would almost hang free, i.e., would only be connected to the parietes by its vessels and nerves. In old and thin people, or after wasting diseases, there is frequently a hollowness on either side of the rectum owing to the absorption of the fat from this part as well as in other portions of the body. A mass of fat enclosed in strong fibrous partitions will also be found over the ischial tuberosities. The fibrous septa are adherent to the skin, and frequently a large uni- or multilocular bursa will be found between these fat masses and the skin. I have rarely found these bursæ in children; they are developed later, and are the result of pressure or friction, and act as pads to prevent the skin being injured by the body weight in sitting, riding, &c. They sometimes enlarge or inflame in people who ride much, and have consequently received the name of 'rider's bursæ.'

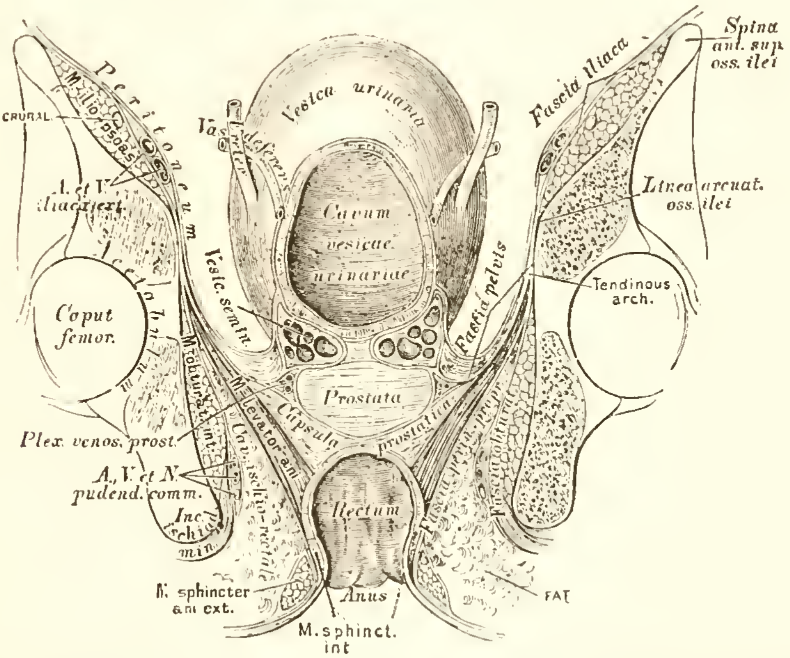


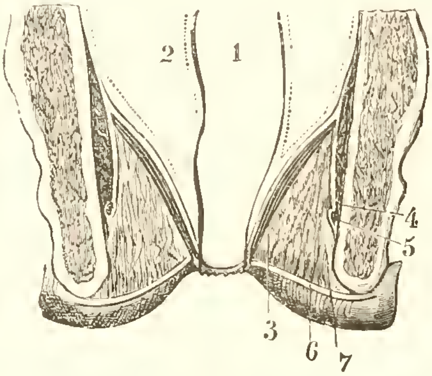
FIG. 463.—VERTICAL TRANSVERSE SECTION THROUGH THE PELVIS, BLADDER, AND RECTUM.

The object of the fibrous septa being adherent to the skin is—as in the case of the skin under the *os calcis*—not only to keep the fat in its place at the point of pressure, but to prevent too much sliding of the skin in sitting, riding, &c., so that the skin which has become accustomed to pressure and friction shall be confined to its place. The loose fatty tissue of the fossæ is frequently the seat of inflammation and abscess, which may burst either externally or into the rectum, or in both directions, forming the various kinds of *fistulæ*. In two cases under my care, both males, there was extensive emphysema following these abscesses. (Mr. Bryant, in his 'Surgery,' mentions a similar case, and Mr. Pusey of Liverpool has recently published in the 'Lancet' a very interesting case of this kind, which however recovered.) This emphysema is fortunately of very rare occurrence, and one which can only be explained by the air having penetrated to the superficial layer of fatty tissue, which is continuous

with that of the rest of the body, or, by the abscess having perforated the fasciæ in the anterior perineal region, allowing the air to ascend along the scrotum to the abdomen, chest, &c.

The source of the air in such cases is either the escape of gas from the rectum passing into the abscess, or it arises from decomposition owing to rapid gangrenous inflammation of the cellular tissue of the fossa; which, like most fatty tissue, is very slightly vascular, and is thus liable to rapid destruction. The suppuration *may* extend to the opposite fossa, but this is unusual in consequence of the separation which exists in the median line or raphé between them. Disease of the lumbar, sacral, or coccygeal portions of the spine, or of the hip or os innominatum, may give rise to abscesses which may burst around the anus. These openings must not be mistaken for ordinary rectal fistula.

Ischio-rectal fossa.—The fat having been cleared away on one side, the following observations may be made. The fossa is a conical space, wider at the surface and behind than above and in front. It is about two



1. Rectum.
2. Peritoneum.
3. Levator ani.
4. Obturator ext.
5. Internal pudic artery, drawn too high up.
6. Skin.
7. Fatty tissue.

FIG. 464.—DIAGRAM OF A TRANSVERSE VERTICAL SECTION THROUGH THE PELVIS, RECTUM, AND ISCHIO-RECTAL FOSSÆ.

Between the lev. ani, rectum, and the peritoneum there is a space which Richet called the *superior pelvi-rectal space.*

inches deep externally, deeper behind than in front, and one inch wide at the surface. Its *inner* wall, formed by the sphincter *ani* and the inferior or outer surface of the levator *ani*, is the longest, and is placed obliquely down and inwards. The coccygeus enters into the formation of this wall *posteriorly*. The *outer* side is vertical, and is formed by the inner surface of the obturator *internus* muscle covered by its fascia, which encloses the internal pudic artery and nerve, and also by the tuber ischii.

Posteriorly, is the lower border of the *gluteus maximus*, and under and external to it is the great sacro-sciatic ligament.

Anteriorly, are the transverse muscle and triangular ligament. There are two pouches in this space; the anterior one is the larger, and passes above the posterior, which latter cul-de-sac passes above the gluteus maximus.

The fossa is covered in by the skin and subcutaneous tissue which form its base, and it is partly covered in at its inner side by the external sphincter and corrugator cutis. Its apex or upper limit is not opposite to the base or orifice, but is placed on its external wall, and is limited by the junction of the fasciæ over the obturator internus and lower aspect of the levator ani.

The outer wall is immovable, but the inner one changes with the contraction or relaxation of the levator ani, and shortens and becomes tense when this muscle contracts, or elongates and approaches the skin when it is in a state of rest.

Directions.—Having mastered the shape, size, boundaries, and actions of the boundaries of this space, the student must proceed to study the *contents* of the opposite fossa. These are the vessels and nerves to the lower part of the rectum and to the anus; they are all branches of the internal pudic artery and nerve. A branch of the fourth sacral nerve, and

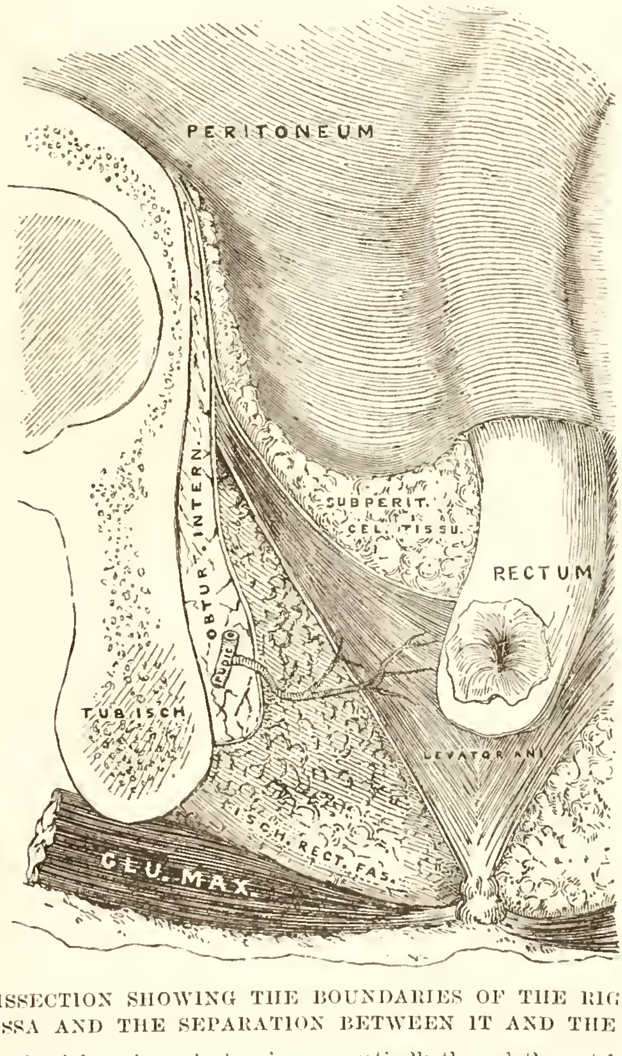


FIG. 465.—DISSECTION SHOWING THE BOUNDARIES OF THE RIGHT ISCHIO-RECTAL FOSSA AND THE SEPARATION BETWEEN IT AND THE PELVIS.

The right os innominatum is sawn vertically through the acetabulum.

one from the inferior or long pudendal from the small sciatic nerve, will also be seen. Before doing this it will be well to learn the attachments of the muscles bounding the space. Three of these muscles are connected with the lower end of the rectum, viz. the external sphincter, levator ani, and internal sphincter. The corrugator cutis ani is a slender subcutaneous muscle, and comes first into view.

Muscles.—The *corrugator cutis ani* surrounds the anus, is very thin and subcutaneous, and composed of involuntary radiating fibres; it passes from the rectal submucous tissue to the skin external to the sphincter.

Action.—Its radial fibres shortening concentrically raise the skin around the anus into radiating ridges.

Nerve.—The inferior hæmorrhoidal.

The **Sphincter Externus** is placed immediately beneath the skin and corrugator, and is an orbicular muscle whose fibres are elliptically arranged around the anus, and like other sphincters it consists of two planes of muscular fibres. It extends half an inch on each side of the anus, and *arises* by a fibrous band—the ano-coccygeal raphé—from the back of the coccyx near its tip, and by some fleshy fibres on either side from the subcutaneous tissue. After surrounding the anus, it passes forwards and blends with the superficial transverse and bulbo-cavernosus muscles, and

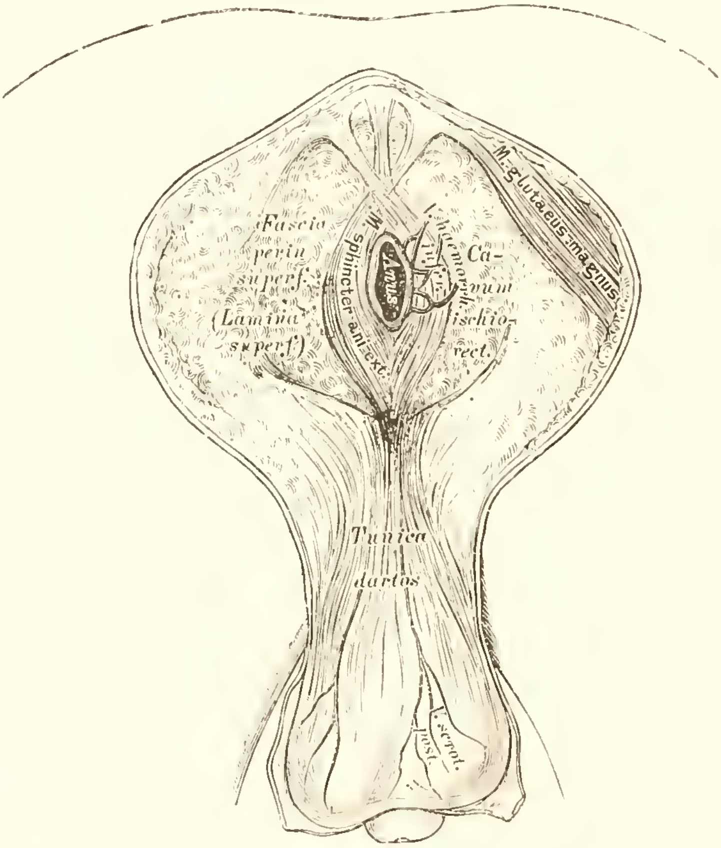


FIG. 166.—SUPERFICIAL DISSECTION OF THE MALE PERINÆUM.

The subject being placed on its face.

is *inserted* into the central point of the perinæum, or ano-bulbar raphé, and by fleshy slips into the superficial fascia. Its deeper fibres form a loop which pass uninterruptedly in front of the rectum.

The ano-bulbar raphé is beneath the point of meeting of the superficial transverse muscles.

Action.—It is usually in a state of involuntary contraction, but this may be voluntarily increased. It closes the anal aperture and puckers up the surrounding skin, and like all the perinæal muscles is contracted during coition.

Relations.—*Superficial* to it are the skin and corrugator, *beneath* it is the lower part of the levator ani, its *inner* border is contiguous to the internal sphincter, and its *outer* extends partly over the ischio-rectal fossa.

Nerves.—Inferior hæmorrhoidal and a branch from the fourth sacral.

Varieties.—These are not of practical importance, but it may be mentioned that there are frequently two layers, a superficial and deep, and that the latter not only surrounds the anus but blends with the lower portion of the rectal walls. Luschka[1] describes a small bursa placed between the coccygeal attachment of this muscle and the fourth coccygeal vertebral body.

The **Sphincter Internus.**—To expose this muscle the mucous membrane at the lower part of the rectum must be made tense by inserting a hook into it, and another to the buttock or table. The incision should correspond to the whitish line before mentioned, at which the skin and mucous membrane join. This line indicates the boundary between the two sphincters, and the mucous membrane is to be carefully dissected from it upwards. This muscle surrounds the last half-inch of the rectum, and is higher or more deeply placed than the external sphincter, from which it is separate. Its fibres are fine and pale, and consist of the lowest *unstriped* and *involuntary* circular fibres of the rectum.

Action.—It assists the external sphincter in closing the anus.

Relations.—The mucous membrane and submucous tissue internally and externally, the external sphincter, levator ani, and inferior hæmorrhoidal vessels and nerves.

Nerves.—From hypogastric plexus of sympathetic.

The **Levator Ani.**—To get a good view of the *insertion* of this muscle, detach the coccygeal origin of the external sphincter and reflect it to one side. This muscle is placed between the interior of the true pelvis, along its brim, and the outer part of the lower end of the rectum. Its origin cannot be seen till the pelvis is dissected, but it may be followed on the dry pelvis. It *arises* in front, by fleshy fibres from the posterior surface of the pubes, midway between its upper and lower edges, and from the back of the triangular ligament; behind from the internal and inferior surfaces of the ischiatic spine, and between these parts by tendinous points from a whitish line on the under surface of the pelvic fascia, as this gives off the obturator fascia. Some of the fibres extend in the fascia to above the level of the obturator internus, and they are often separated by cellular intervals. The white line, or aponeurotic arch, is concave superiorly. From this origin it passes down and in, the fibres converging to be *inserted* in the following manner. The *anterior* fibres, which are the fewest and longest, pass between the bladder, prostate, and rectum, and along their sides (forming the *compressor prostatæ* of some authors), they then join the muscle of the opposite side in the central perinæal point, and blend with the external sphincter and deep transverse muscle;[2] the *posterior* fasciculi are attached to the side of the lower end of the coccyx, and those just in front of the coccyx join in a median raphé with its fellow of the opposite side, as far forwards as the anus; the *middle* part of this muscle is the largest, and passes on the side of the rectum, blend-

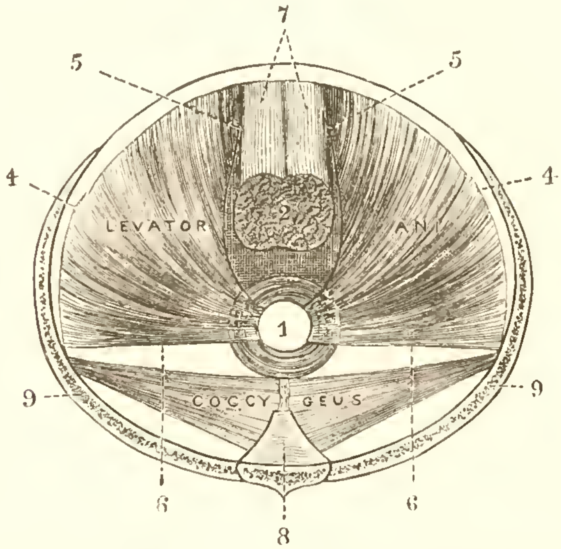
[1] *Die fascia pelvina*, Wien, 1859, p. 13.

[2] By reflecting the superficial transverse muscle of one side, the fibres of insertion to the bulb (*ano-bulbar*), which are below the bulbo-cavernosus, will be exposed, and by detaching the deep transverse muscle, the insertion into the membranous urethra will be exposed. These may be seen in a muscular subject during the dissection of the anterior space.

ing with the fibres of the external sphincter, and to a less extent with those of the internal, and is *inserted* into the skin around the anus.[1]

Action.—It raises and inverts the lower end of the rectum, especially its posterior part, and aids in replacing the mucous membrane which has been protruded and everted during defæcation. It also supports the lower part of the rectum, vagina, bladder, urethra, prostate, and vesiculæ seminales during expulsive efforts. The posterior portion may move the coccyx up and to one side, and also raise the posterior part of the anus.

Relations.—These are important. This muscle has two surfaces and three borders, and enters into both the anterior and posterior perinæal regions. Its *upper or pelvic* surface is concave, and is covered by the recto-vesical part of the pelvic fascia, its *lower or perinæal* aspect is convex downwards, and is covered by the anal fascia. It forms the *inner* boundary of the ischio-rectal fossa, and is in contact with the middle perinæal fascia



1. Rectum.
2. Prostate.
5, 5. Anterior border of levator ani.
6, 6. Posterior ,, ,,
7. Anterior vesical ligaments.
8. Coccygeus.
9, 9. Ilium (cut).

FIG. 467.—DIAGRAM OF A HORIZONTAL SECTION OF THE PELVIS TO SHOW THE MUSCLES OF THE PELVIC DIAPHRAGM FROM ABOVE.

in front, with the external sphincter in the middle, and with the cellulo-fatty layer of the ischio-rectal fossa behind.

The middle perinæal fascia being *transversely* and this muscle *obliquely* placed, there exists, in consequence, a space filled with fatty tissue between the two; this is the *anterior* prolongation of the ischio-rectal fossa already mentioned. Its external border is its origin, its internal edge extends from the pubes to the rectum, and is in relation with the rectum, prostate, and pubo-rectal aponeurosis, and its posterior transverse border passes between the ischial spine and the rectum, and is parallel to the

[1] The anterior origins of this muscle are frequently separated by cellular tissue. This and the fact that they descend to the sides of the prostate, have caused them to be described and named by Santorini, and subsequently by Albinus, Sömmering, Winslow, and Weber-Hildebrandt, as a separate muscle, the *levator constrictor* or *compressor prostatæ*. In the female, these anterior fibres descend on the sides of the vagina. Henle, in his *Handbuch d. systematischen Anatomie des Menschen*, last edition, describes a layer of involuntary muscular fibres, with some interspersed voluntary fibres, which passes behind the prostate and its venous plexus to join the opposite muscle. This layer rests on the junction of the sphincter ani and bulbo-cavernosus, and he has named it the *præ-rectalis*.

anterior border of the ischio-coccygeus. The muscles of opposite sides are separated in front by a triangular interval in which is the triangular ligament, and through this pass the urethra in the male, and vagina in the female.

Nerves.—From the internal pudic and third and fourth sacral nerves, which latter pierce or pass between it and the ischio-coccygeus; it has also some twigs from the anterior superficial perinæal nerve.

The **Ischio-coccygeus.**—Some anatomists say that this is only the posterior part of the levator ani, but as it is often pretty distinct, I shall describe it as a separate muscle. It *arises* from the posterior part of the

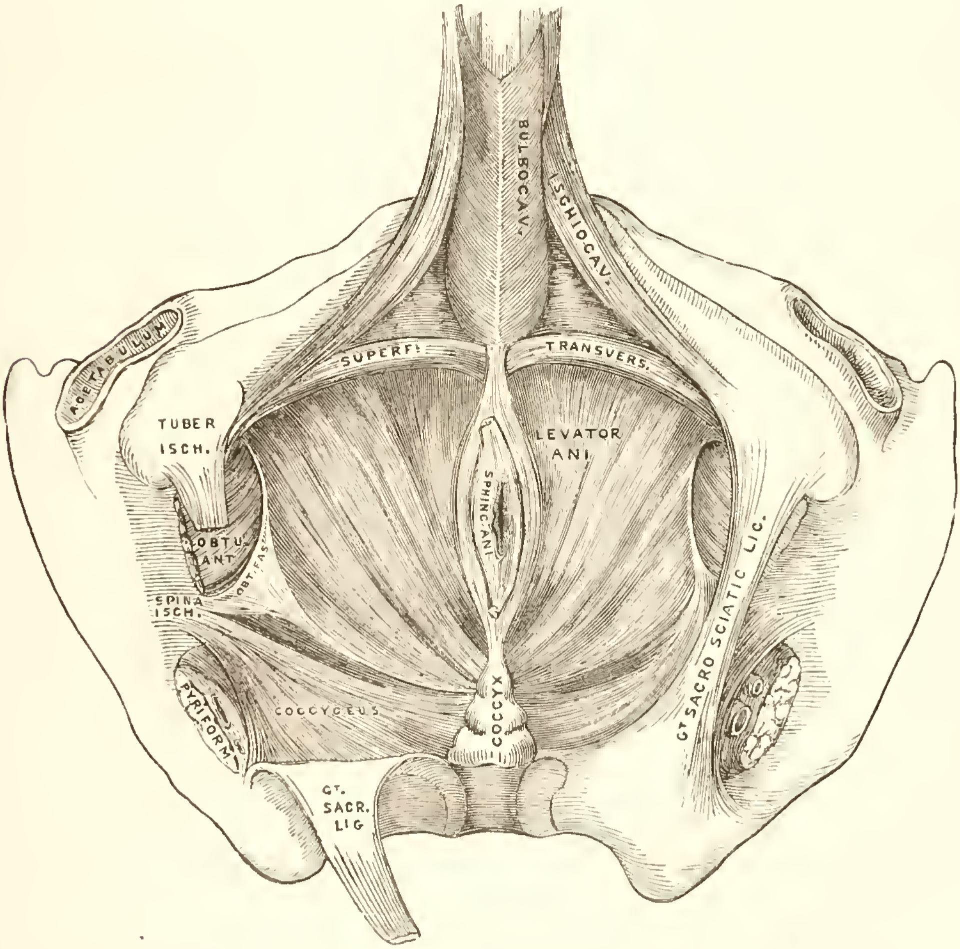


FIG. 468.—MUSCLES OF THE PELVIC DIAPHRAGM, SEEN FROM BELOW.

The sciatic vessels and nerves are shown cut, coming out in front of the pyriformis.

tendinous arch or white line of the pelvic fascia, and is *inserted* into the side of the coccyx and into the ano-coccygeal raphé.

Action.—It assists the posterior part of the levator ani.

Nerve.—The same as that of the levator ani.

The **Coccygeus, levator, or spino-coccygeus,** is situated between the posterior border of the levator ani and the small sciatic ligament. Its under surface may be seen by removing a portion of the gluteus maximus of one side, so as to expose the great sacro-sciatic ligament. This may be divided at its middle and reflected. Some of the fibres of the gluteus

will be found to be connected with the posterior surface of the ligament. It is a triangular, short and flat muscle, with fleshy and tendinous fibres, and *arises* by its apex from the upper part of the ischial spine and lesser sciatic ligament, and is *inserted* by its base to the side and part of the anterior surface of the coccyx and last piece of the sacrum.

Actions.—It raises the coccyx after it has been pushed back during defæcation, and supports it during parturition.

Relations.—Its *pelvic surface* is in contact with the rectum on the left side, its *external or lower surface* rests on the front of the small sacro-

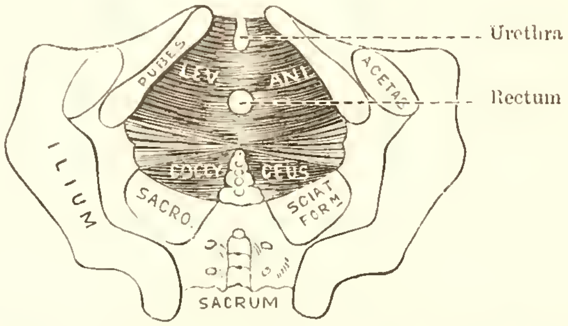


FIG. 469.—ANTERIOR PART OF LEVATOR ANI, SEEN FROM BELOW.

sciatic ligament and gluteus maximus, its *anterior or inferior edge* is parallel with the posterior border of the levator ani, and its *posterior or superior border* is separated from the pyriformis by some vessels and nerves; the sacro-sciatic ligaments are also partly above it. It completes the *pelvic or genito-rectal diaphragm* posteriorly.[1]

Nerves.—The fourth and fifth sacral, and coccygeal.

Varieties.—It occasionally has two heads of origin, and is sometimes

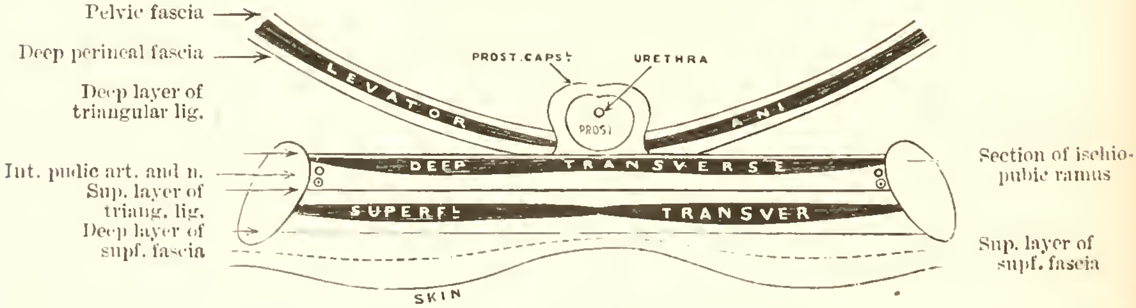


FIG. 470.—DIAGRAM OF VERTICAL TRANSVERSE SECTION OF THE PERINÆUM.

attached to the sacrum instead of the coccyx. Macalister, in his paper on 'Muscular Anatomy,' p. 66, mentions that Von Behr and other anatomists have described some fibres passing from the lower end of the sacrum to the front and back of the coccyx, and have named the anterior set *curvator*, and the posterior, *extensor coccygis*. I will describe them separately.

The *Sacro-coccygeus posterior*, or *extensor coccygis* of Theile, consists of a few slips *arising* from the lower part of the back of the sacrum, or from

[1] Some French and German anatomists, Meyer among the latter, consider the symmetrical group of muscles in the perinæum as one continuous sheet meeting in the mid-line, and regard them as forming, and justly so, the *pelvic or genito-urinary diaphragm*.

the posterior inferior iliac spine, and *inserting* into the back of the coccyx. It is frequently present.

The *Sacro-coccygeus anterior*, or *curvator coccygis* of Von Behr, occupies a corresponding position in front of the sacrum and coccyx, and is less constant than the preceding muscle. These fibres represent some of the caudal muscles of the lower animals. Their names indicate their actions, and filaments from the lower sacral nerves supply them.

Dissection.—On the undissected side, the student must carefully remove the fat in a direction corresponding to that of the vessels and nerves, which run for the most part transversely or obliquely inwards; those to the posterior part of the anus and rectum pass back, and those for the urethra and muscles of the anterior space course forwards. He must note that the superficial pad of fat is separated from a deeper layer by the inferior hæmorrhoidal vessels and the posterior twig of the perinæal branch of the internal pudic nerves. These must be traced outwards to their

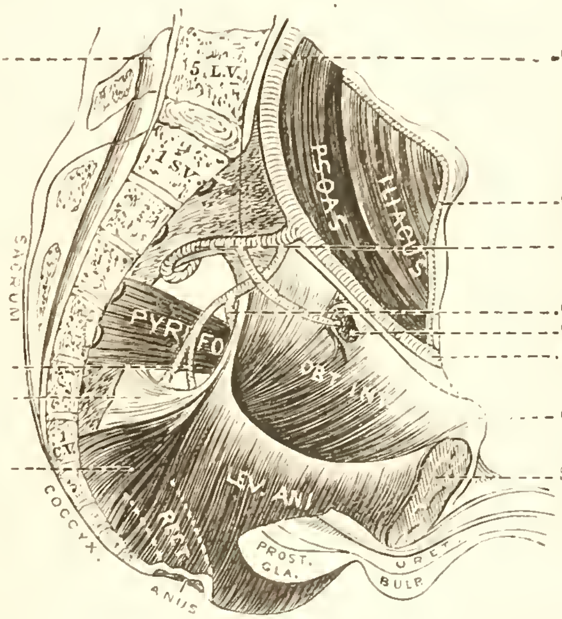


FIG. 471.—VERTICAL MEDIAN SECTION OF THE PELVIS.

Left side seen from within and the viscera removed.

origin from the internal pudic artery and nerve, which may be felt along the outer wall, in an aponeurotic sheath of the obturator fascia. At the posterior part of the fascia the artery is about an inch and a half from the surface, or from the lower margin of the ischial tuberosity, but only half an inch from the surface at the anterior part of the space, where it passes under and then pierces the triangular ligament to get between its layers and to divide into its two terminal branches, viz. the *artery to the corpus cavernosum and the dorsal artery of the penis.*

The *pelvic and gluteal portions* of the internal pudic artery and nerve will be subsequently dissected; only the perinæal portion is seen in this dissection.

Instructions.—Feel the structures just mentioned, and roll them under the finger; define the posterior edge of the triangular ligament, feel the sacro-sciatic ligaments and the spine of the ischium. By referring to the

dried pelvis with the ligaments attached, and to the woodcuts, their relative positions will be ascertained.

Arteries.—The **Pudic or Internal Pudic artery** comes from the anterior division of the internal iliac, and occasionally by a common trunk with the sciatic, and is of large size, but smaller in the female. It is distributed mainly to the genital organs and lower end of the rectum, and furnishes almost all the vessels to the structures in both perinæal spaces. Only the posterior part of the artery is now to be dissected. It leaves the pelvis through the *great* sacro-sciatic foramen, taking a curved course, and accompanied by the nerve, it re-enters the pelvis through the *lesser* sacro-sciatic foramen just *below* the ischial spine, *behind* which it passes; it then runs forward on the *inner* side of the tuber ischii *external* to the ischio-rectal fossa but *internal* to (i.e. nearer the mid-line) the obturator internus,

FIG. 472.—RIGHT LEVATOR ANI. INNER ASPECT.

although on the *outer or perinæal* surface of that muscle. In this fossa the following branches are given off.

The Inferior or External hæmorrhoidal, two or three in number, cross the fossa through the fat to the lower end of the rectum, and to the external sphincter, levator ani, and skin around the anus and over the anterior part of the perinæum.

It anastomoses on the rectum with the superior hæmorrhoidal from the inferior mesenteric, and middle hæmorrhoidal from the anterior trunk of the internal iliac, and joins the superficial perinæal branch in front. Some *muscular* twigs to the anterior part of the levator ani may be seen at the front of the fossa.

A few twigs of the *sciatic* artery to the inner surface of the gluteus maximus, and to the skin and fat in its neighbourhood, may be seen at the back of the space.

Veins.—These are the venæ comites of the arteries, and empty themselves into the internal pudic vein, which ends in the internal iliac vein.

Nerves.—Corresponding and similarly named branches to those of the artery issue from the pudic or internal pudic nerve, which, like the artery, supplies nearly all the structures in these regions. A filament from the fourth sacral, and some cutaneous branches of the small sciatic, are also found in this fossa. On the back of the coccyx is the fifth sacral, and at its sides and near its tip are the coccygeal nerves.

The **Pudic or internal pudic** nerve comes from the third and fourth

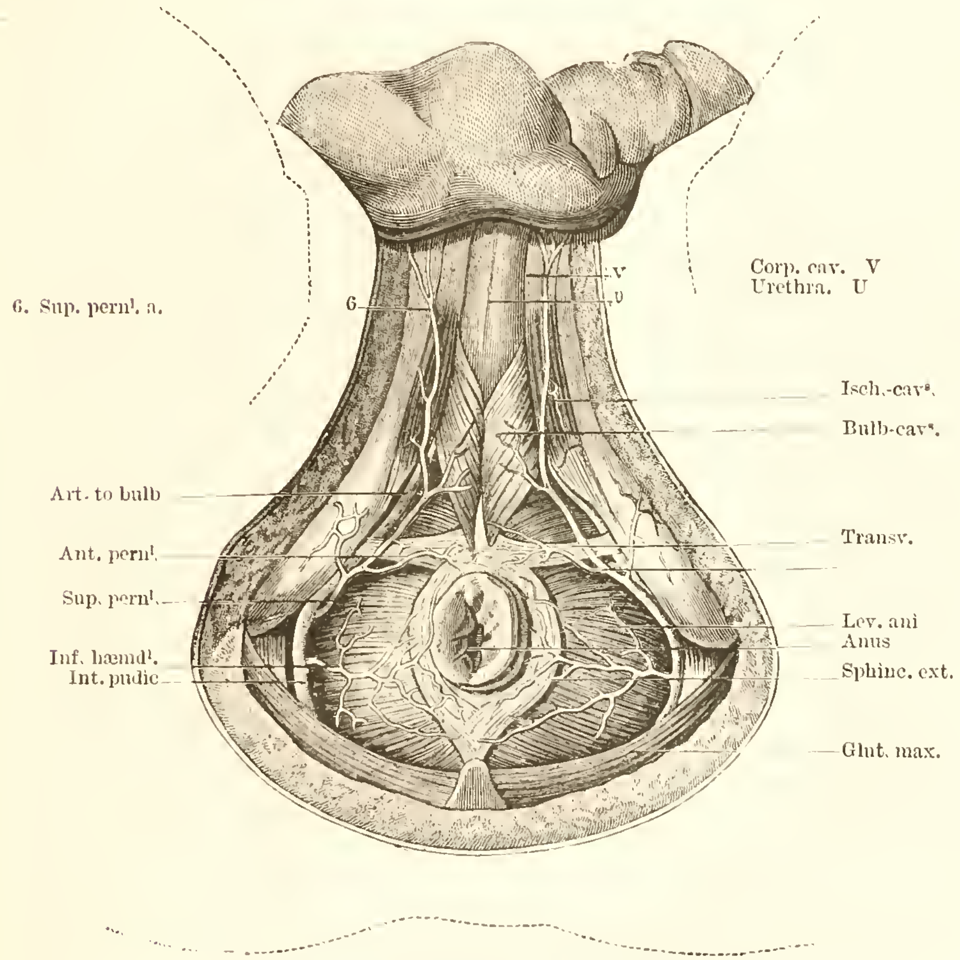


FIG. 473.—ARTERIES OF MALE PERINÆUM.

sacral nerves and takes the same course as the artery. It is more deeply placed than the artery, and in the fossa gives off the two following branches. It then passes forward, and ends as the dorsal nerve of the penis.

The Inferior hæmorrhoidal nerve arises from the pudic at the back of the pelvis, or may issue directly from the sacral plexus. In the latter case it passes through the small sacro-sciatic foramen. It crosses the fossa and supplies the external sphincter and skin around it. Some cutaneous filaments pass forwards and anastomose at the thigh margin with the inferior pudendal of the small sciatic and with the posterior supplemental perinæal offsets of the pudic.

The perinæal nerve is much larger than the preceding, and is situated lower, being beneath the pudic artery. It is also larger than the continuation of the pudic nerve to the penis, and is given off at about the middle of the outer wall and soon lies superficial to the vessels. Its branches are

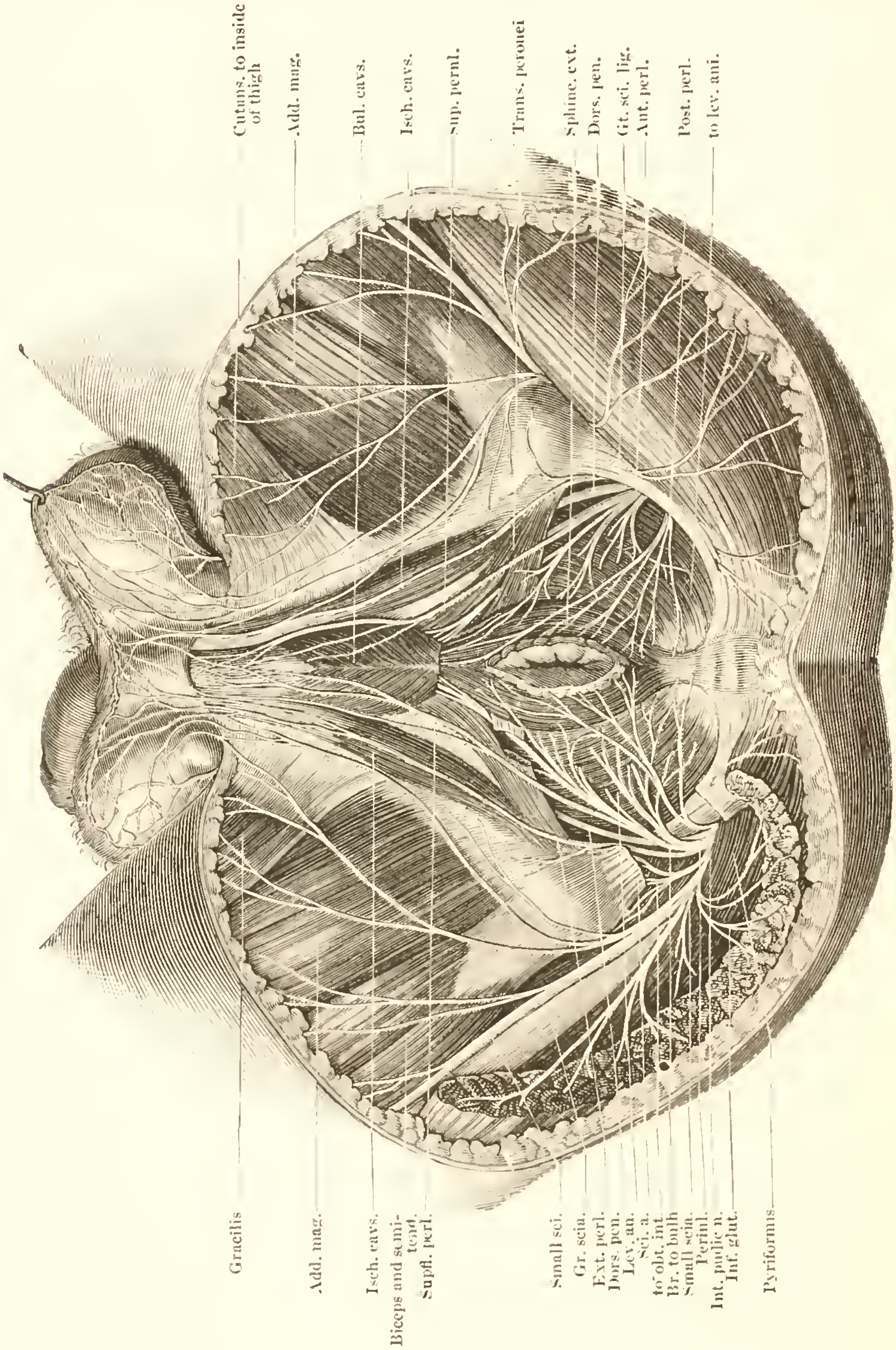


FIG. 474.—NERVES OF MALE PERINÆUM.

The right gluteus max. and great sacro-sciatic ligament cut. The inferior gluteal branches to gluteus max., the inferior pudendal to scrotum, and the upper parts of the sciatic nerves are shown. The cutaneous branches to skin over buttock are depicted on the left gluteus maximus.

muscular, cutaneous, and genital, of which only the cutaneous will now be partly dissected.

The Superficial perinæal nerves are partly seen in the fossa. They are named the *posterior* and *anterior superficial perinæal*; the former is

the first given off, is placed at the back of the space and supplies the skin in front of the anus, accompanying the anterior to the scrotum and joining the inferior hæmorrhoidal and inferior pudendal nerves.

The *anterior* is found at the fore part of the fossa accompanying the superficial perinæal artery; it is under the *superficial transverse* muscle, and supplies the skin at the forepart of the scrotum and that on the under surface of the penis. The levator ani and external sphincter receive twigs from this branch.

The inferior or long pudendal branch of the *small sciatic* accompanies these nerves to the scrotum, and joins the posterior perinæal. In the female these nerves supply the skin of the labia majora.

The *sphincteric* or *hæmorrhoidal* branch of the fourth sacral is seen near the coccyx, and supplies the external sphincter and skin between the anus and coccyx. It reaches its destination by piercing either the levator ani or coccygeus, or by passing between them. The branches of the *small sciatic nerve* seen in this dissection are the *internal cutaneous and inferior pudendal.* The former are for the supply of the thigh and buttock, and turn over the inferior edge of the gluteus maximus to the skin of these parts, and are found at the posterior and external part of the fossa. The latter will be dissected presently.

THE GENITO-URINARY TRIANGLE.

Dissection.—Raise the skin carefully from the underlying superficial fascia, following the directions as to the incisions which were given in the preceding section. The dissector should see if some muscular fibres, generally scattered, but occasionally well developed and concentrated, are present. If so, they may pass from the fat over the tuber ischii to the raphé, external sphincter and levator ani. This arrangement is rare, and depends apparently on the development of the superficial transverse muscle. It is more common to see muscular fibres passing from the ischio-rectal fat either in or outwards, to blend with the superficial fascia. Should this muscle be present there will be three transverse muscles; *the cutaneous, the superficial or middle, and the deep.* It has been named the *subcutaneous transverse.* The superficial perinæal fascia is now exposed, and is composed of two layers, between which seek the continuations of the cutaneous vessels and nerves, partly described in the last section, and trace them back to their origins. Then cut through the *superficial layer of the perinæal fascia* midway between the raphé and rami of pubes and reflect it, and note that it is *not adherent* to the lateral bony boundaries, and that it, like the subcutaneous cellulo-fatty layer or superficial fascia in the groin, buttock, abdomen, and upper part of the thigh, with which it is continuous, varies in the amount of fat contained in its meshes with the condition of the body generally as to obesity. Insert the fine end of a blow-pipe beneath the *posterior part* of the *deep layer* of this fascia at one side, and observe its membranous structure, also the median partition, which is incomplete at the anterior part of the space, allowing the air to cross the median line. If the inflation be forcible enough, the air will be projected along the scrotum and penis on to the abdomen, but *not usually on to the thighs* because this

layer is adherent to the pubic rami. Pus or urine extravasated under this layer generally follows this course and does *not pass backward*, because this deep layer of the superficial perinæal fascia is continuous around the posterior border of the *superficial transverse* muscle with the anterior layer of the *middle perinæal fascia*, which latter is also called the *triangular ligament*. Observe that *at the sides* this deep layer of the superficial perinæal fascia, which is called by some the *fascia of Colles*, is attached to the anterior lip of the margin of the rami of pubes and ischium, external to the crus and erector penis, and as far back as the tuber ischii. *Anteriorly* it is unattached, and is continuous with the *dartos* of the scrotum and the fascia of the penis as far as the base of the *glans*. From the deep surface of this layer is given off a vertical septum which is attached to the urethral bulb in the mid-line, but is incomplete in front towards the scrotum.

This septum imperfectly divides the pouch included between this layer and the anterior layer of the triangular ligament into two lateral halves, and between these layers are contained the three superficial muscles of this region, viz. the *bulbo-cavernosus* over the urethral bulb, the *ischio-cavernosus* over the crus penis, and the *superficial transversus perinæi*; also the superficial perinæal vessels and nerves. In consequence of this arrangement of the fascia this pouch is completely separated from the ischio-rectal region, so that rectal fistulæ are almost always situated behind the *inter-ischiatic line*, which corresponds very nearly to the line of junction of these fasciæ, and urethral fistulæ are placed, ordinarily, in front of it.

From ten years' experience as a teacher of anatomy, I know well that students generally have much difficulty in comprehending clearly the arrangement of these fasciæ. Having just given the arrangement usually described, I will add a statement which has forced itself on me through repeated dissections and from surgical and pathological observations. I am quite aware that it differs from the majority of authors, but I am sure that the dissector will observe it to prevail in the large majority of subjects, and I think he will find it easy of comprehension. Anatomists have differed much in the description and nomenclature of the fasciæ, and students have been bewildered, but the matter is sufficiently simple, and I trust that the following brief description will render it more easy to be understood by the reader.

The fasciæ of the perinæum are three, the *superficial, the middle and the deep*, and these envelope the muscles which close the pelvic outlet, forming their *sheaths or apomyoses*.[1] In the perinæum there are three layers of muscles, the *superficial, middle, and deep*; the two former will presently be dissected, and the deep form the pelvic diaphragm already alluded to in the previous section. They are, from before backwards, the levator ani, ischio-coccygeus, coccygeus, and pyriformis. These three layers of muscles have each (on both surfaces, of course) their special sheaths, which are continuous with each other, and thus form the various fasciæ of this region, so that these three planes of muscles are enclosed between four layers of fascia, thus; the *superficial muscles*, between the two layers, formed, as will be presently described, of the middle perinæal fascia; the *middle muscles*, between the deep layer of the middle perinæal fascia and the deep perinæal

[1] This term is more correct than aponeurosis.

fascia; and the *deep muscles*, between the deep perinæal and pelvic fasciæ. By thus assimilating the deeper fasciæ in this region to that of similar structures in other parts of the body, and considering them as *apomyoses*, as they undoubtedly are, their comprehension and description is much facilitated. It will now be clear that there are four planes of fasciæ enclosing three groups of muscles, viz. the superficial, the middle, and the deep *perinæal* fasciæ, the fourth layer being part of the true fasciæ of the pelvis, separating the deepest part of the perinæum from the pelvic cavity, limiting the pelvic outlet, and being only separated from the peritoneum by loose cellulo-fatty tissue. Although these fasciæ cannot now all be seen, it will assist the student to understand them if a succinct account be at once given.

The **Superficial Perinæal Fascia**, or *subcutaneous cellulo-fatty layer*, may

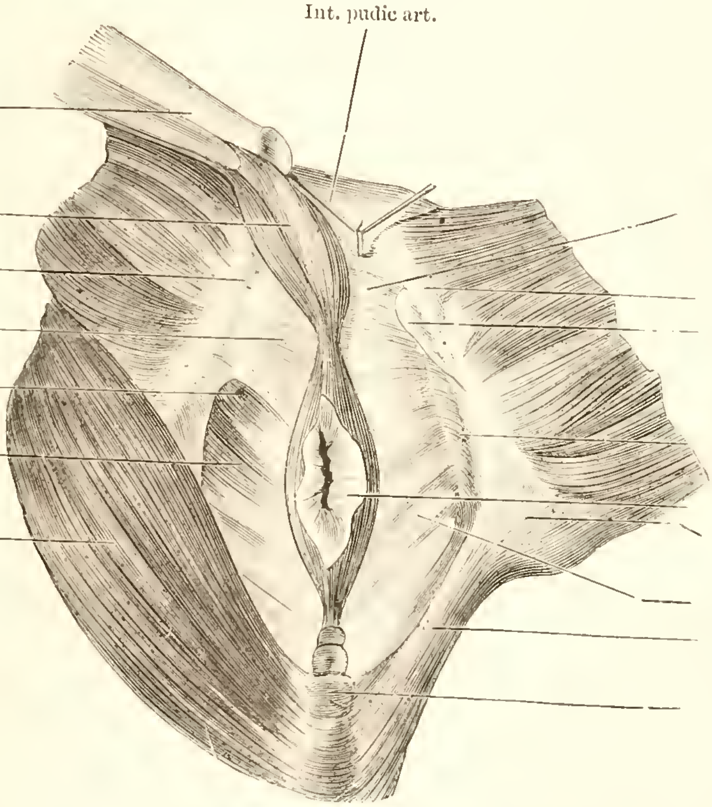


FIG. 475.—PERINÆAL APONEUROSES OF THE MALE.

be dissected into two layers, and is continuous with that of surrounding parts, and passes into the thighs, into the ischio-rectal fossa, and around the anus to the buttocks, and is attached to the sides of the coccyx. In front, it loses its fat and runs into the *dartos*, or more correctly forms an extremely thin and firm band of union between the *dartos* and skin of the scrotum, and passes on to the penis and abdomen. Between this and the *middle perinæal fascia* are the cutaneous vessels and nerves which pierce and supply the superficial fascia to reach the skin.

Directions.—To demonstrate the attachment of the middle fascia, cut through it on one side, midway between the pubic arch and the mid-line, and reflect it, removing any fat, and define the septum in the middle.

The **Middle Perinæal Fascia**, or *apomyosis*, is a thin membranous

structure, which is unattached in front and is continuous with the scrotal *dartos*, but is attached laterally to the anterior lip of the descending rami of the pubes and ascending rami of the ischium, in front of the crus and erector penis and as far back as the tuber ischii. It passes round the lower border of the *superficial transverse* muscle to reach its deep surface, and is attached laterally to the posterior margins of the same bones behind the crus and erector, and superiorly to the inferior margin of the symphysis pubis.

By this reflection, recurvation, or folding of itself round the transverse muscle, two layers are formed, a *superficial*, called Colles' fascia, and a *deep*.[1] These are really continuous, and form parts of one and the same fascia, the deeper layer being the stronger. Between the two layers of this fascia are the superficial perinæal muscles, viz. the *erector penis*, *accelerator urinæ*, and *superficial transverse*, with parts of the transverse vessels and superficial perinæal vessels and nerves.

Practical Applications.—Matter or urine extravasated between the

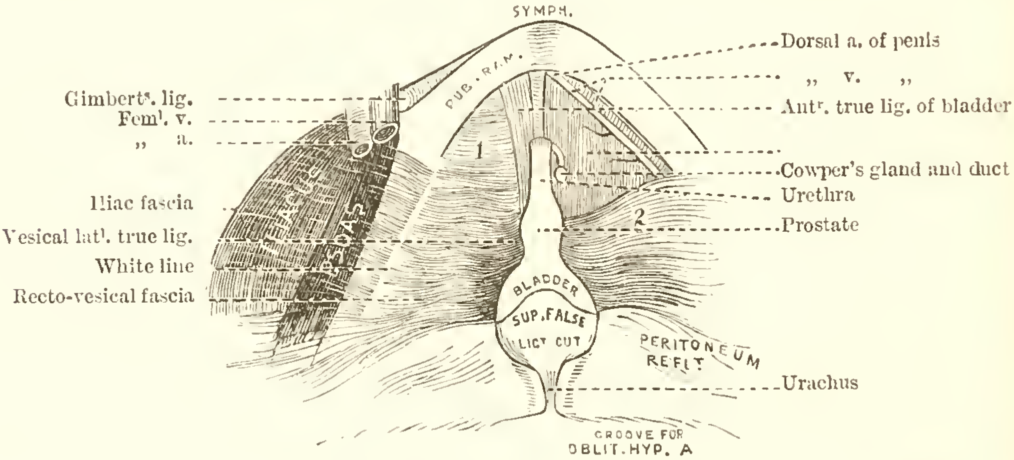


FIG. 476.—DISSECTION OF THE MALE PELVIS SEEN FROM ABOVE AND WITHIN TO SHOW THE TRIANGULAR LIGAMENT.

The dissection has been carried deeper on the right side of the subject. 1. Deep layer of triangular ligament continuous with that part of the recto-vesical fascia which forms a sheath for the prostate. 2. Recto-vesical fascia cut to show the anterior layer of the triangular lig. On the left side the anterior fibres of the lev. ani have been removed to expose the deep layer of the triangular lig. The iliac portion of the pelvic fascia is seen passing over the iliacus and psoas to become continuous with the recto-vesical fascia, and forming the deep layer of the triangular lig. The urethra has been divided and the bladder and peritoneum stretched backwards.

superficial fascia and the anterior layer of the middle may pass in all directions, but if confined between the two layers of the middle fascia, it cannot pass back, because of the reflection round the transverse muscles, and it cannot pass on to the thighs because of the attachments to the rami of pubes and ischium, but it *can and does* pass forwards to the scrotum, penis, and abdomen, because here it is not bound down. This is the rule, but I have seen two or three exceptions to it, which were due in one case, as proved at the *post mortem*, to ulceration through these attachments, and perforation of the superficial layer of this fascia, and exit of the urine and pus into the thighs and into the ischio-rectal fossæ and buttocks. In other cases there may be natural gaps in the fasciæ or in their attachments, and judging

[1] This deep layer is, according to most anatomists, a separate membrane forming the ant. or inf. layer of the *triangular ligament of Carcassonne*. It has also been called the *subpubic fascia* and the *transverse ligament* of the perinæum. In fact its names are much too numerous and have caused great confusion.

by individual differences in other structures, there is no reason why a similar condition should not occasionally prevail with the various fasciæ.

In rupture of the membranous urethra, which is contained between the deep layer of the middle fascia and the deep fascia proper, the urine generally takes a similar course to that which it assumes when it is confined between the two layers of the middle fascia, because the deep layer

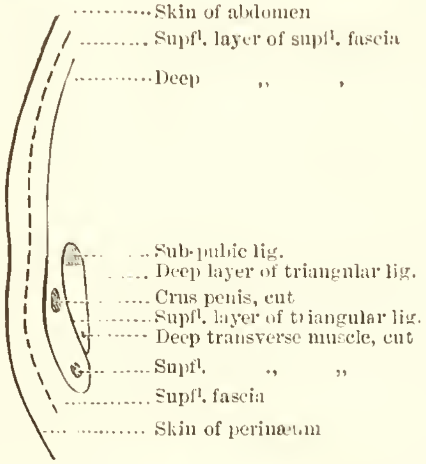


FIG. 477.—DIAGRAM OF PERINÆAL FASCIÆ.

A vertical antero-posterior section has been made immediately to the right of the penis and scrotum.

of the middle fascia is torn by the injury or ulcerated through by the inflammation caused by the urine. It may however infiltrate back into the pelvis, and cause death by pelvic cellulitis or peritonitis. Hence the urgency of free and deep incisions in the middle line, or even cystotomy by the lateral or median incision.

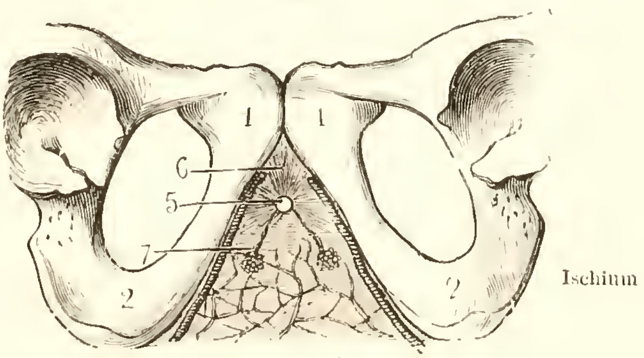


FIG. 478.—THE MIDDLE PERINÆAL FASCIA OR TRIANGULAR LIGAMENT, AND SOME OF THE STRUCTURES BETWEEN ITS LAYERS.

1. Pubes. 2. Ischium. Around the urethra the fibres radiate.

The *deep perinæal fascia or aponeurosis* will be better understood further on, when its dissection is reached. It is partly continuous behind with the pelvic fascia, and in front with the deep layer of the middle fascia, forming a separate pouch, partition, or compartment, in which are found the *membranous part of the urethra, the deep transverse and constrictor muscles, Cowper's gland, and parts of the pudic vessels and nerves and*

artery to the bulb. Between the *deep perinæal and pelvic* fasciæ are the *anterior fibres of the levator ani and Wilson's muscle.*

The student will note that the superficial fascia has practically two layers (although more may artificially be made); the middle has two layers, and the deep only one.

Dissection.—The *superficial vessels and nerves* may be prepared on the side on which the fascia has been reflected. The vessels are the *transverse and superficial perinæal.* Two superficial perinæal nerves accompany the vessels, and the inferior pudendal, which pierces the fascia lata one inch in front of the tuber ischii and the same distance from the ischial ramus, should be traced to the scrotum, and its junction with the inferior hæmorrhoidal behind and perinæal in front should be made out. Some of the fatty tissue on the inner side of the thigh must be removed to trace out the inferior pudendal nerve.

Contents.—In the *anterior half* of the perinæal space are the *bulb, the membranous portion of the urethra and muscles surrounding it, and part of the corpora cavernosa* with their vessels and nerves. On the *outer* side course the larger vessels and nerves.

The *ischio-urethral triangle* is exposed when the superficial layer of the middle fascia is reflected. It is bounded *externally* by the crus penis

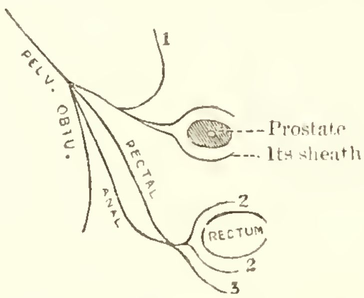


FIG. 479.—DIAGRAM OF PELVIC AND PERINÆAL FASCIÆ OF RIGHT SIDE.

1. Lateral vesical true ligament. 2. Sheath of rectum. Seen from the front.

covered by the ischio-cavernosus muscle, in the *mid-line* by the bulb covered by the bulbo-cavernosus, and behind by the superficial transversus perinæi. Its floor is formed by the deep layer of the middle perinæal fascia, and it is covered by the superficial layer of the middle fascia, by the two layers of the superficial fascia, and by the skin. It contains parts of the pudic artery and nerve, and of their superficial perinæal branches.

The *central perinæal raphé, tendon, or point* is now seen. It is a white fibrous spot in the mid-line, about half an inch in front of the anus. The urethral and rectal muscles join in it, and it is a *point d'appui* between the anterior and posterior spaces. Three long cutaneous nerves to the scrotum and external labium, the long pudendal, and the superficial perinæal, will be found in this space.

Nerves.—The *inferior or long pudendal nerve* comes from the small sciatic, turns forward below the ischial tuberosity, and pierces the fascia lata about an inch in front of the tuber ischii and nearly the same distance on the *outer* side of the ramus of the ischium, and passes forwards beneath the superficial fascia, with the perinæal nerves, to supply the skin at the fore and outer part of the scrotum in the male, and the labia majora in the

female. It joins the posterior superficial perinæal and inferior hæmorrhoidal nerves.

Superficial Perinæal Nerves.—These have been partly described in the preceding section, and are two, anterior and posterior. They are branches of the perinæal branch of the pudic nerve.

The *Posterior Superficial Perinæal* is found passing from the back to the front of the ischio-rectal fossa, and getting beneath the superficial fascia, passes forwards, with its accompanying artery and with the anterior nerve, to the back of the scrotum, where it communicates with the inferior pudendal and anterior perinæal. In the fossa it gives branches to the sphincter ani and skin in front of the anus. These anastomose with the inferior hæmorrhoidal nerve.

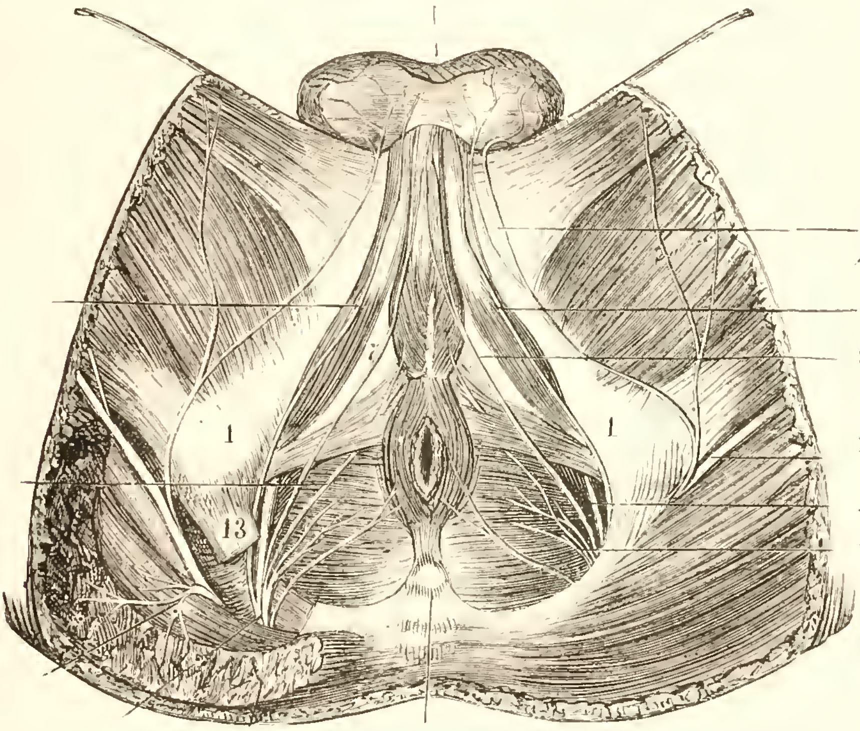


FIG. 480.—NERVES OF MALE PERINÆUM.

1. Ischium. 2. Scrotum. 13. Great sacro-sciatic ligament cut. 7 is placed in the triangle bounded by the supf^l. transverse muscle behind, the ischio-cavernosus outside, and the bulbo-cavernosus in the mid-line. The ext. sphincter, lev. ani, origins of the adductors, and on the left of the figure the origins of the hamstrings, are shown.

The *Anterior Superficial Perinæal* appears at the anterior part of the ischio-rectal fossa, passes under the transversalis perinæi muscles, and accompanies the posterior perinæal nerve to the back of the scrotum and under part of the penis. It gives filaments to the levator ani and transversus perinæi, and is accompanied by the superficial perinæal artery. These nerves are accompanied to the scrotum by the inferior pudendal branch of the small sciatic nerve, and the three are sometimes named *long scrotal nerves*. They supply the scrotum by long slender filaments which reach to the under surface of the penis. In the female they end in the labia majora.

The *muscular branches* of the perinæal nerve will be seen as the dissection proceeds.

Dissection.—Remove the cellulo-fatty tissue and vessels and nerves from one side, say the left; also the thin layer of fascia which is above the muscles. The muscles superficial to the triangular ligament will then be exposed. There are three; the one in the middle being the ejaculator urinæ, that on the outer side is the erector penis, and a small muscle at the back part of the space, running nearly transversely inwards, is the transversus perinæi. These three muscles enclose the triangular space

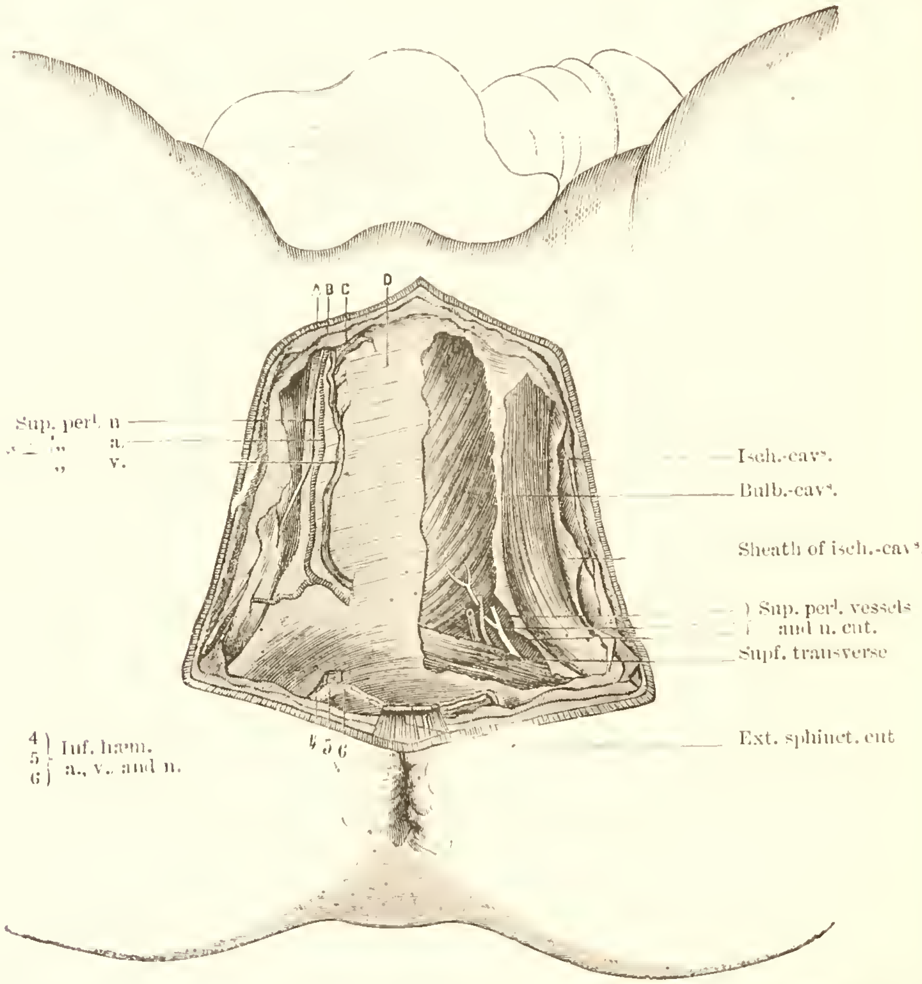


FIG. 481. SUPERFICIAL DISSECTION OF MALE PERINÆUM. THE FASCIA REMOVED ON LEFT SIDE.

A. Skin. B. Supf. fascia. C. Deep layer of supf. fascia. D. Deep fascia.

in which the superficial perinæal muscles and nerves will be found, and beneath the transversalis the muscular branch of the perinæal nerve should be defined.

The **Erector Penis**, or **Ischio-cavernosus**, embraces the unattached part of the crus penis, and is narrower at each end than in the middle. It *arises* by tendinous and fleshy fibres from the inner part of the tuber ischii, behind the attachment of the crus penis to it, and also from the pubic arch on either side of the crus. The fibres pass forwards to a ten-

dinous expansion which is spread over the under surface of the crus, and is *inserted* into the outer and under surface of the forepart of the crus.

Action.—It compresses the crus against the bone, and assists in producing or in maintaining erection of the penis by preventing the escape of blood from the distended veins.

Nerve.—The perinæal.

Relations.—It lies on the crus and root of the penis, and on the bone, and has the superficial fascia above it (in this position) and forms the outer boundary of the triangle already mentioned.

Varieties.—Two slips of muscle, apparently belonging to the erectores penis, but separated by a slight interval from them, have been described by Houston and named by him *compressores venæ dorsalis penis.* They arise from the pubic arch above the attachments of the crura and erectors, and passing up and forwards, join each other in the mid-line, where they are above the dorsal vein. They are inconstant in man, but are well developed in the dog and several other animals.

The **Ejaculator Urinæ**, or **Bulbo-cavernosus**, or accelerator urinæ, is com-

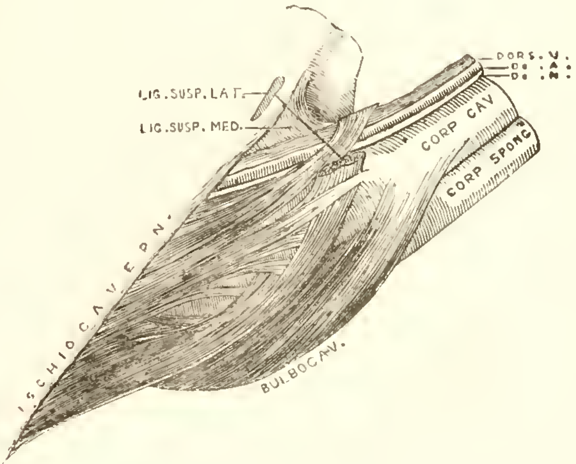


FIG. 482.—DISSECTION OF THE MUSCLES AT THE ROOT OF THE PENIS. RIGHT SIDE.

posed of two symmetrical halves united in the mid-line by a tendinous raphé. It may be considered as a single muscle which *arises* from this median tendon and from the central point of the perinæum. Its fibres diverge and form a thin layer, the most posterior of which are inserted on the anterior surface of the triangular ligament. The middle fibres encircle the bulb and neighbouring part of the corpus spongiosum urethræ, as far forwards as the union of the corpora cavernosa, and join the fibres of the opposite muscle in a strong aponeurosis on the upper part of the corpus spongiosum. The anterior fibres are the most distinct and the longest; they spread out on the sides of the corpora cavernosa, and are *inserted*, partly into their outer parts anterior to the insertion of the erector penis, and partly by a tendinous expansion over the dorsal vessels of the penis.

Actions.—The two lateral portions, acting as one muscle, compress the bulb and neighbouring part of the corpus spongiosum, so as forcibly to eject any fluid which may be in the canal. It is relaxed during micturition, but can be voluntarily contracted towards the end of that process; but in seminal emission it acts involuntarily. The anterior fibres being in-

serted over the dorsal vein can assist in maintaining erection, and the middle fibres are stated by Krause to assist in erection by compressing the erectile tissue of the bulb and keeping the corpus spongiosum distended.

Relations.—Superficially, with the deep layer of the superficial fascia; *deeply*, with the bulb and urethra for three inches in front of the triangular ligament; *externally*, with the superficial perinæal vessels and nerves and erector penis; *posteriorly*, with the transversus perinæi and transverse artery; and the artery of the bulb pierces it.

Nerve.—The perinæal.

Variety.—The deeper fibres investing the most prominent part of the bulb are separated by some thin areolar tissue from the superficial layer.

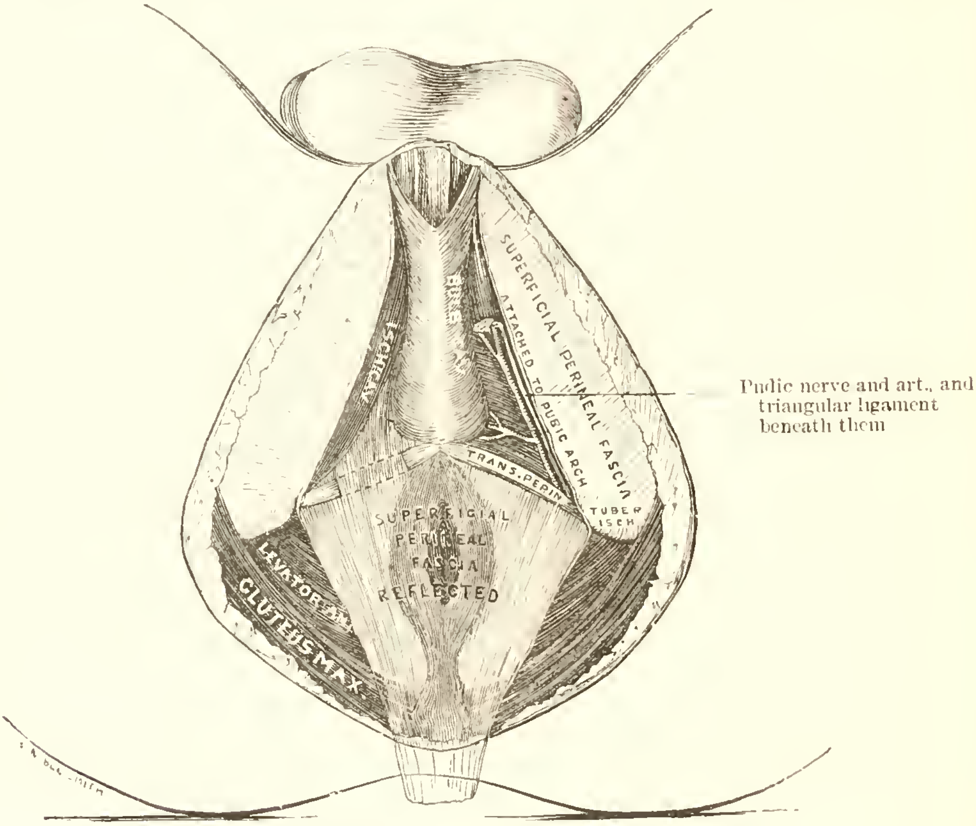


FIG. 483.—SUPERFICIAL DISSECTION OF PERINÆUM.

The deep layer of the superficial fascia is reflected, and on the left its continuation with the triangular ligament is shown.

They join the corresponding part of the muscle of the opposite side by a small tendon above the urethra. Kobelt has described them as a separate muscular stratum, and named the muscle *compressor hemisphericus bulbi*.

Dissection.—Divide the ejaculator on one side longitudinally, and reflect it from the penis so as to see its junction with its fellow above the urethra and above the corpora cavernosa.

The **Transversus**, or **Transversalis Perinæi**, is a narrow, thin, inconstant muscular slip which crosses the perinæum obliquely along the base of the triangular ligament. It *arises* by a small tendon from the inner and fore-part of the ischial tuberosity, and passing forwards and inwards joins the

muscle of the opposite side in the central perinæal point. At this latter spot it also joins the accelerator urinæ in front and the sphincter ani behind. Around the *posterior border* of this muscle the deep layer of the superficial fascia joins the anterior layer of the triangular ligament.

Action.—The two acting together will draw back and fix the central point of the perinæum, and so help to steady it previous to the contraction of the ejaculator. This backward movement of the central point will help to relax the sphincter ani.

Relations.—*Superficially*, the superficial fascia ; *deeply*, the triangular ligament, the transverse artery, the artery to the bulb, and anterior superficial perinæal nerve. The posterior superficial perinæal nerve and artery run above it at its outer side.

Variety.—There is occasionally a second muscular slip in front of or behind it which is inserted into the ejaculator. It has been called the *transversalis alter.* It may be absent.

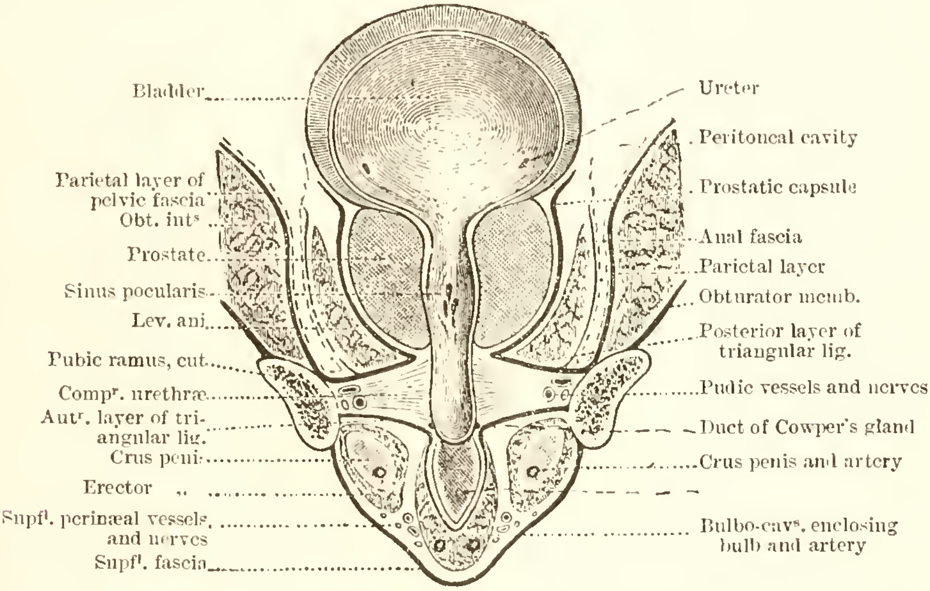


FIG. 484.—DIAGRAM OF A VERTICAL LONGITUDINAL SECTION THROUGH PELVIS AT PUBIC ARCH TO SHOW THE TWO PERINÆAL COMPARTMENTS AND THEIR CONTENTS.

Altered from Cunningham.

Nerve.—The perinæal.

These three muscles bound a triangular space which is covered in by the deep layer of the superficial fascia, and the floor of which is formed by the anterior layer of the triangular ligament. It contains the superficial perinæal vessels and nerves which run forwards in it, and the transverse perinæal artery which runs inwards along its base.

Dissection.—On one side, say the left, remove the ejaculator from the front of the triangular ligament and the erector from the crus penis. Carefully divide the crus near its attachment to the bone so as not to injure the triangular ligament or the terminal branches of the pudic artery and nerve. The deep branches of the perinæal vessels and nerves should be defined on the right side beneath the transversalis muscle.

The **Triangular Ligament of the Urethra,** or **Deep Perinæal Fascia,** is a strong membranous layer which supports the urethra and closes the anterior part of the pelvic outlet. It is triangular, and about an inch and a

half deep in the mid-line, and is attached above, by its apex, to the under surface of the symphysis pubis and subpubic ligament, and on each side to the rami of pubes and ischium, beneath the crura penis. Its base, or inferior margin, is towards the rectum, and is connected in the mid-line to the central perinæal point; while laterally it is free, and slopes obliquely towards the tubera ischii. It is continuous around the posterior border of the transversus perinæi with the deep layer of the superficial fascia, and also with the thin fascia covering the levator ani.

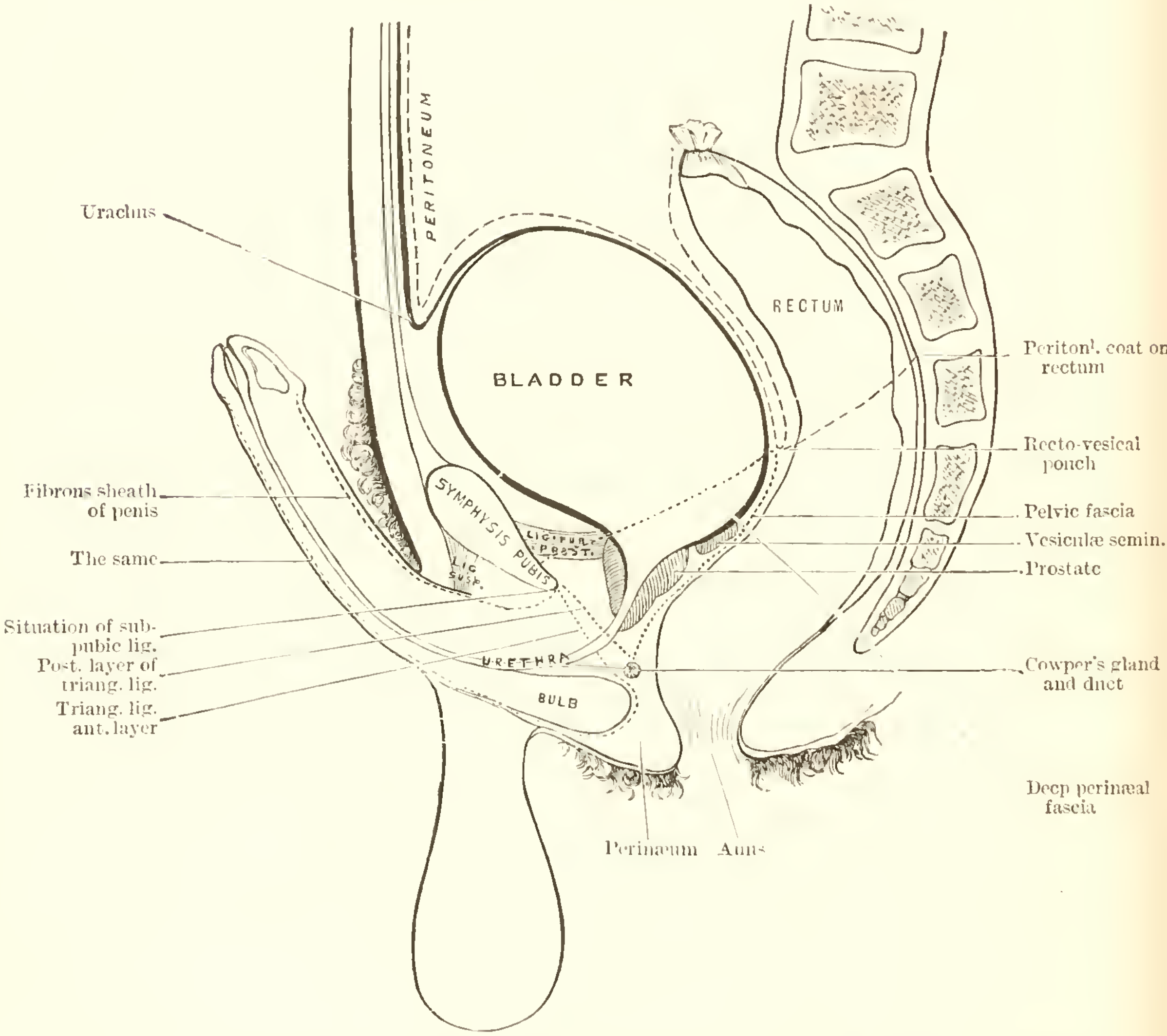


FIG. 185.—DIAGRAM OF ANTERO-POSTERIOR VERTICAL SECTION OF MALE PELVIC ORGANS TO SHOW THE PERINÆAL FASCIA.

Cowper's gland has been inserted, although it is to one side of the rectum.

It is pierced about an inch below the symphysis by the urethra, but the margin of the opening is blended with the fibrous covering of the corpus spongiosum. About midway above this is the aperture for the dorsal vein of the penis, and external to this, near the bone on each side, the pudic artery and nerve pierce the ligament by separate apertures.

The **Deep Perinæal Fascia** consists of two layers, anterior and posterior, which are separated above but join below. The anterior layer is formed

chiefly of transverse fibres, and is united at its base with the deep layer of the superficial fascia. It is continued forwards around the anterior part of the membranous portion of the urethra, and is lost upon the bulb. The posterior layer is continuous with the recto-vesical division of the pelvic fascia, and is also continuous with the anterior layer of the deep perinæal fascia above, and passes back around the posterior part of the membranous urethra and the outer surface of the prostate gland.

Relations.—Superficial to the anterior layer are the three muscles just described, and the superficial perinæal vessels and nerves; and between the two layers are, from above downwards, the subpubic ligament, the dorsal vein of the penis, the membranous part of the urethra and its muscles, Cowper's glands and their ducts, the pudic vessels and nerves, the artery

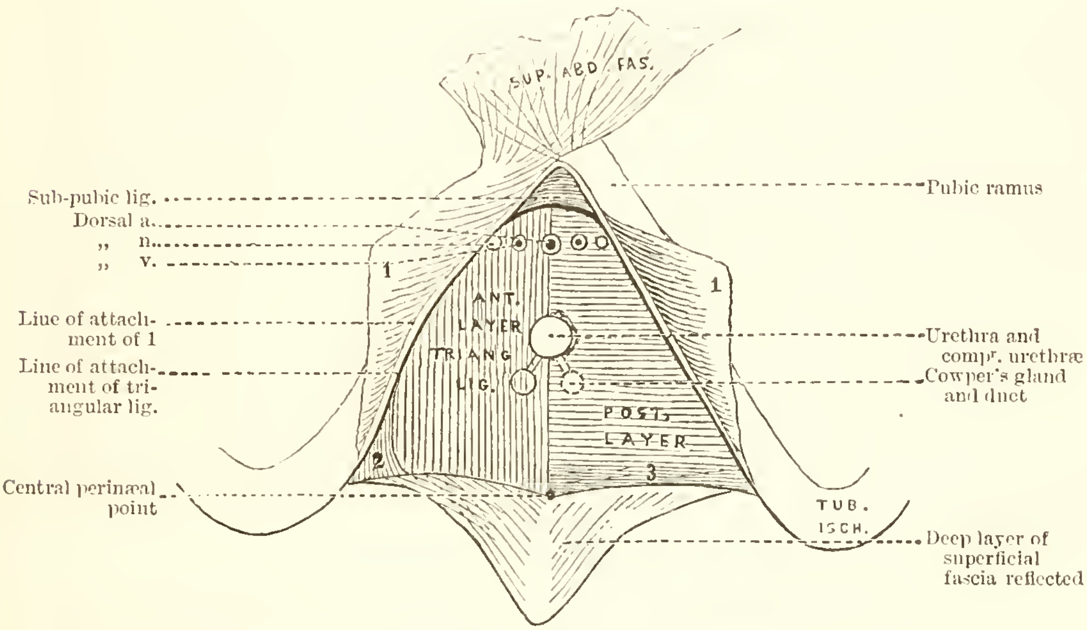


FIG. 486.—DIAGRAM OF THE TRIANGULAR LIGAMENT OF COWPER.

1. Deep layer of superficial fascia. 2. Its junction with the anterior layer of the triangular ligament behind the supf[l]. transverse muscle. 3. The blending of the two layers of the triangular ligament posteriorly. On the left of the figure the continuation of 1 with the superficial abdominal fascia is shown. The two layers of the triangular ligament are differently shaded for the sake of diagrammatic clearness. Excepting Cowper's glands all the structures between the triangular ligament and the deep layer of supf[l]. perinæal fascia have been removed.

and nerve to the bulb, and a venous plexus. To see these, the following directions must be obeyed.

Dissection.—On the left side carefully divide the anterior layer of the deep perinæal fascia near the pubic arch; raise it and reflect it inwards; carefully clean any structures exposed, and remove the veins if necessary.

Position of parts between the layers of the Deep Perinæal Fascia.—In the mid-line, below the pubes, is the subpubic ligament, and below this are the dorsal vein of the penis and membranous part of the urethra, below which are the ducts of Cowper's glands, the latter being beneath the deep transverse muscle. Near the base of the ligament is the deep transverse muscle; and above it, passing inwards from behind the pubic arch to the urethra, is the constrictor urethræ which surrounds the membranous urethra. Close to the pubic arch on either side are the pudic vessels and

nerves, the latter being deeper than the artery, which here gives its branch to the bulb. The *posterior* layer of the fascia, which separates these structures from the pelvic cavity, is placed beneath these structures. The *deep lymphatic vessels* of the penis accompany the dorsal vein.

Muscles.—There are two of these in connection with the membranous portion of the urethra. They are the constrictor or compressor urethræ, and the deep transverse muscle.

The **Constrictor Urethræ**, or **Constrictor Isthmi Urethralis**, or **Orbicular muscle of the urethra**, consists of a number of transverse fibres which enclose the membranous part of the urethra and pass, some above and others below it. It *arises* by aponeurotic fibres from the upper part of the pubic ramus on each side for half or three quarters of an inch, and from the posterior layer of the triangular ligament. Each half of the muscle passes inwards, and divides into two layers which surround the membranous urethra, one set passing over, the other under that canal, from the prostate behind to the bulb in front, and unite by a tendinous raphé on the upper and lower surfaces of the urethra with the muscles of the opposite side. It may be regarded as a single muscle extending across the perinæum, and enveloping the urethra in the same manner as the sphincter ani encloses the lower end of the rectum.

Action.—Both muscles act as a single sphincter, and diminish the calibre of the membranous urethra expelling its contents. It is relaxed during micturition, but at the end of that process it contracts and assists the ejaculator in emptying the canal.

Relations.—Its *inner surface* is in relation with the circular involuntary muscular fibres of the urethra, and its *outer* with the deep layer of the triangular ligament, which separates it from the anterior fibres of the levator ani. It is enclosed between the two layers of the deep fascia.

Nerve.—The perinæal.

Variety.—The tendinous raphé is not constant.

The **Deep Transversus Perinæi**, or **Levator Urethræ of Santorini**, or **Guthrie's muscle**, is inconstant, and is a thin flat layer near the base of the triangular ligament. It *arises* from the margin of the pubic arch, and passes obliquely in, behind the bulb and the membranous part of the urethra, to the mid-line, where it joins its fellow of the opposite side, and is *inserted* into the central perinæal point.

Action.—It will, like the superficial transverse muscle, fix the central point of the perinæum.

Relations.—It conceals Cowper's gland, is between the two layers of the deep fascia, and has the pudic artery and nerve beneath it at its outer side, and the artery of the bulb above its upper border.

Nerve.—The perinæal.

Variety.—It may be absent, and is not always separated from the preceding muscle.

Dissection.—Carefully divide the thin constrictor urethræ muscle to expose the involuntary circular fibres surrounding the membranous urethra.

The **Circular Muscular Fibres** are immediately beneath the transverse fibres of the constrictor, and are continuous posteriorly with the circular fibres of the prostate and bladder. They surround the urethra from the

bulb to the prostate. This layer is a part of the large involuntary sphincter muscle surrounding the commencement of the urethra, of which the prostate is the major part.

Variety.—An unstriped band of fibres, called *pubo-vesical*, has been described by Luschka as passing from the back of the symphysis to the upper part and sides of the neck of the bladder.

Action.—It aids in expelling the contents of the urethra.

Wilson's Muscle, or the **pubo-urethral**, is variable and inconstant. Some anatomists regard it as formed by the anterior fibres of the levator ani, and others as only the posterior part of the deep transverse, but Wilson's muscle is situated above the latter, has a different direction, and is separated from it by a delicate fibrous layer. It corresponds to the posterior part of the membranous urethra. It *arises* on either side from the under

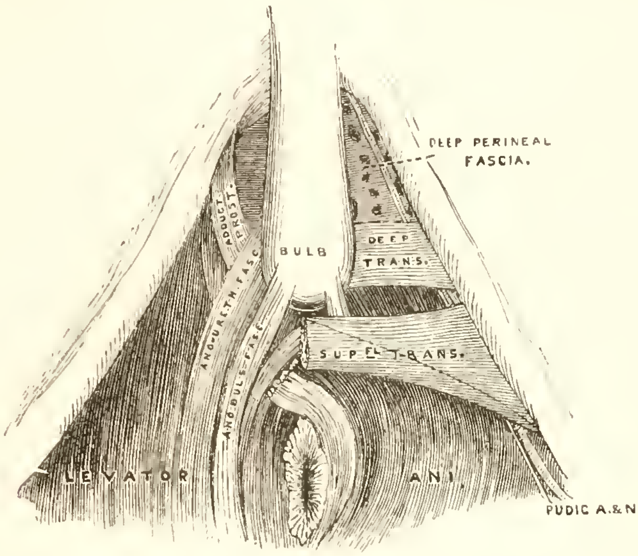


FIG. 487.—DISSECTION OF ANTERIOR PART OF LEVATOR ANI AND OTHER PERINÆAL MUSCLES.

The external sphincter surrounds the anus, and its superficial fibres are cut on the right of the figure, but its deep fibres are shown on the left passing to the front of the rectum. The ano-urethral and adductor or compressor prostatæ are parts of the lev. ani, and the ano-bulbar fibres may come from the lev. ani or from the deep part of the ext. sphincter.

surface of the symphysis, and is inserted into the suburethral raphé, forming a loop which embraces the posterior part of the urethra. Its middle fibres pass directly from the triangular ligament to the upper part of the urethra, and form a layer between the pubo-prostatic plexus above, the urethra below, the prostate behind, and the angle of union of the corpora cavernosa in front. It is separated on each side from the anterior fibres of the levator ani by the lateral apomyosis of the prostate.

Actions.—It raises the urethra towards the symphysis, and aids in the expulsion of the urine and semen, and can compress the pubo-prostatic plexus.

Nerve.—The internal pudic.

Cowper's Glands are placed immediately below the membranous urethra, just behind the bulb and below the artery to that structure. If the transverse muscle be carefully divided and reflected, it will be fully exposed.

Each gland is of about the size of a pea, and consists of lobules held together by connective tissue. The lobules are made up of small vesicles which are lined by squamous epithelium. The duct of each gland is nearly an inch in length, and is minute. It obliquely perforates the corpus spongiosum, and opens into the urethra about half an inch in front of the triangular ligament. In its wall are unstriped muscular fibres, and

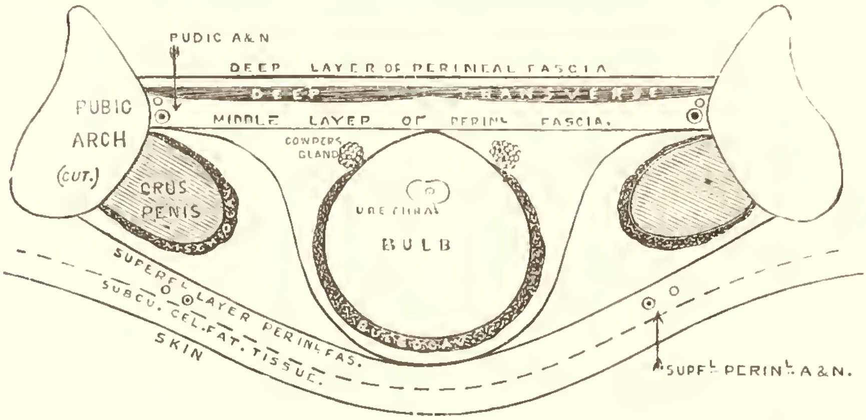


FIG. 488.—DIAGRAM OF VERTICAL TRANSVERSE SECTION THROUGH THE PERINEAL FASCIÆ AND BULB.

its mucous lining is covered by columnar epithelium. In old men they are much decreased in size.

Directions.—The anterior parts of the pudic vessels and nerves and their branches must be now traced out.

The nerve accompanies the artery, but is more deeply placed.

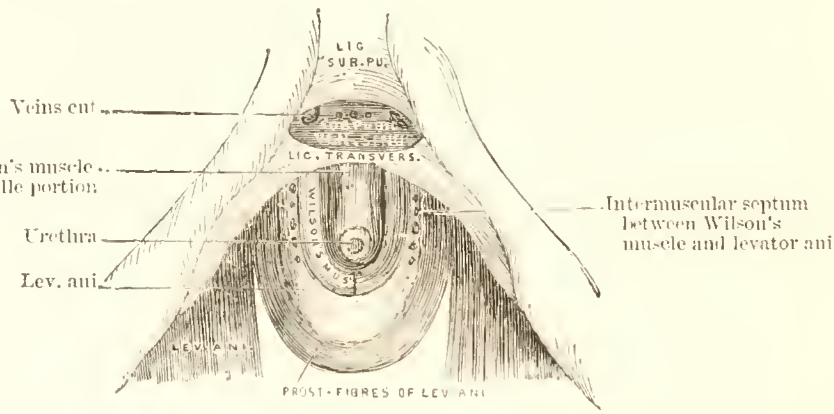


FIG. 489.—DISSECTION OF WILSON'S MUSCLE.

The bulb and anterior part of the membranous urethra have been removed.

The **Pudic, or Internal Pudic Artery**, is the smaller of the two terminal branches of the anterior division of the internal iliac, and is destined for the supply of the perinæum and external genital organs. It is smaller in the female. Its posterior portion in the perinæum has already been dissected. Its anterior part, after piercing the posterior layer of the deep perinæal fascia runs forwards between the layers of that fascia along the

inner margin of the pubic arch nearly to the pubes, where it perforates the superficial layer of the deep perinæal fascia or triangular ligament, and divides into its two terminal branches, viz. the dorsal artery of the penis, and the artery of the corpus cavernosum.

Relations.—In this part of its course it is between the two layers of the deep perinæal fascia, close to the pubic arch, and usually beneath the deep transverse muscle. The membranous urethra and its branch to the bulb are on its inner side, and the nerve is deeper than the vessel. It is accompanied by venæ comites, and gives off the following branches; viz.

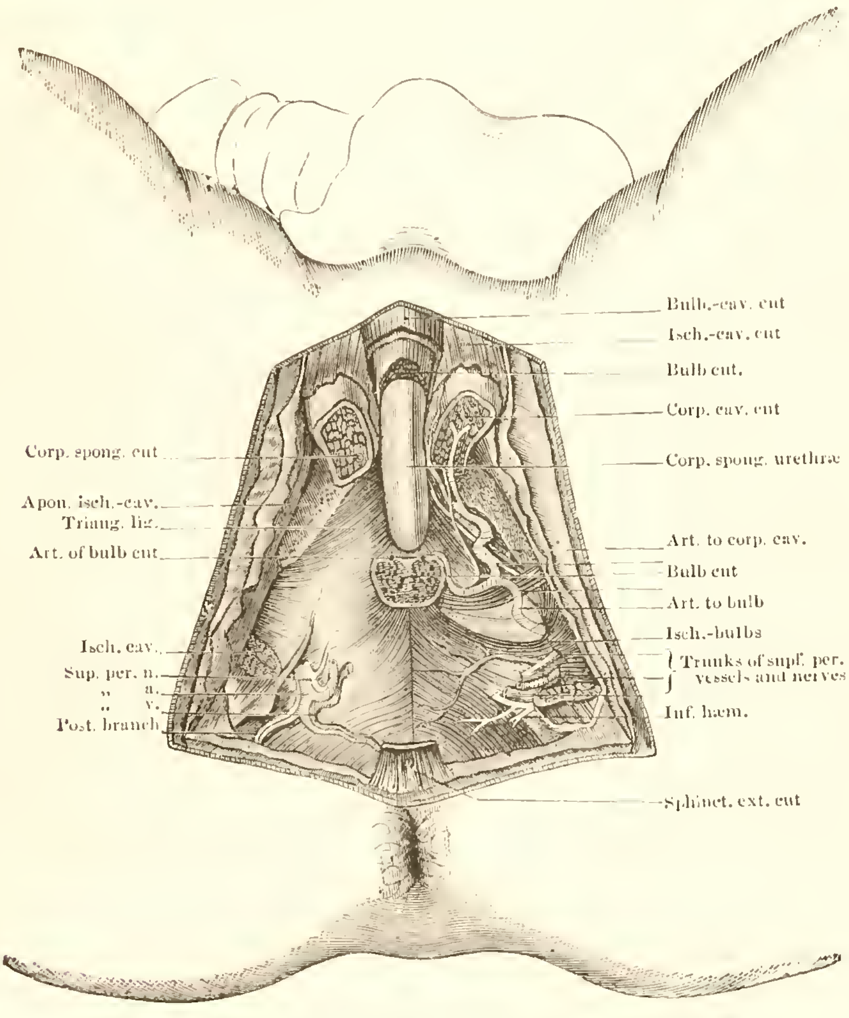


FIG. 490.—DEEPER DISSECTION OF MALE PERINÆUM.

the artery of the bulb, muscular, the artery of the corpus cavernosum, and the dorsal artery of the penis.

The Artery of the Bulb is a large but short vessel, which is given off near the base of the triangular ligament, and passes between the two layers of the deep perinæal fascia obliquely inwards, about half an inch from its base to the back of the bulb, which it pierces, and supplies it and the corpus spongiosum. A small branch to Cowper's gland is given off by it near the urethra.

Varieties.—It is sometimes small, occasionally double, and may be altogether absent. It may arise earlier, i.e. further back in the perinæum

than usual, and would then reach the bulb from behind. In the latter case it would be altogether below the base of the triangular ligament, would cross the front of the ischio-rectal fossa, and would be very liable to be wounded in the lateral operation for lithotomy. On the other hand, should it arise from an *accessory pudic artery*, it would be placed more forward than usual, and is out of danger in the latter operation.

Muscular Branches are given off to the constrictor urethræ, and levator and sphincter ani, as the vessel is about to pierce the posterior layer of the triangular ligament.

The artery of the corpus cavernosum (*profunda penis*), is one of the terminal branches of the internal pudic, arising from that vessel

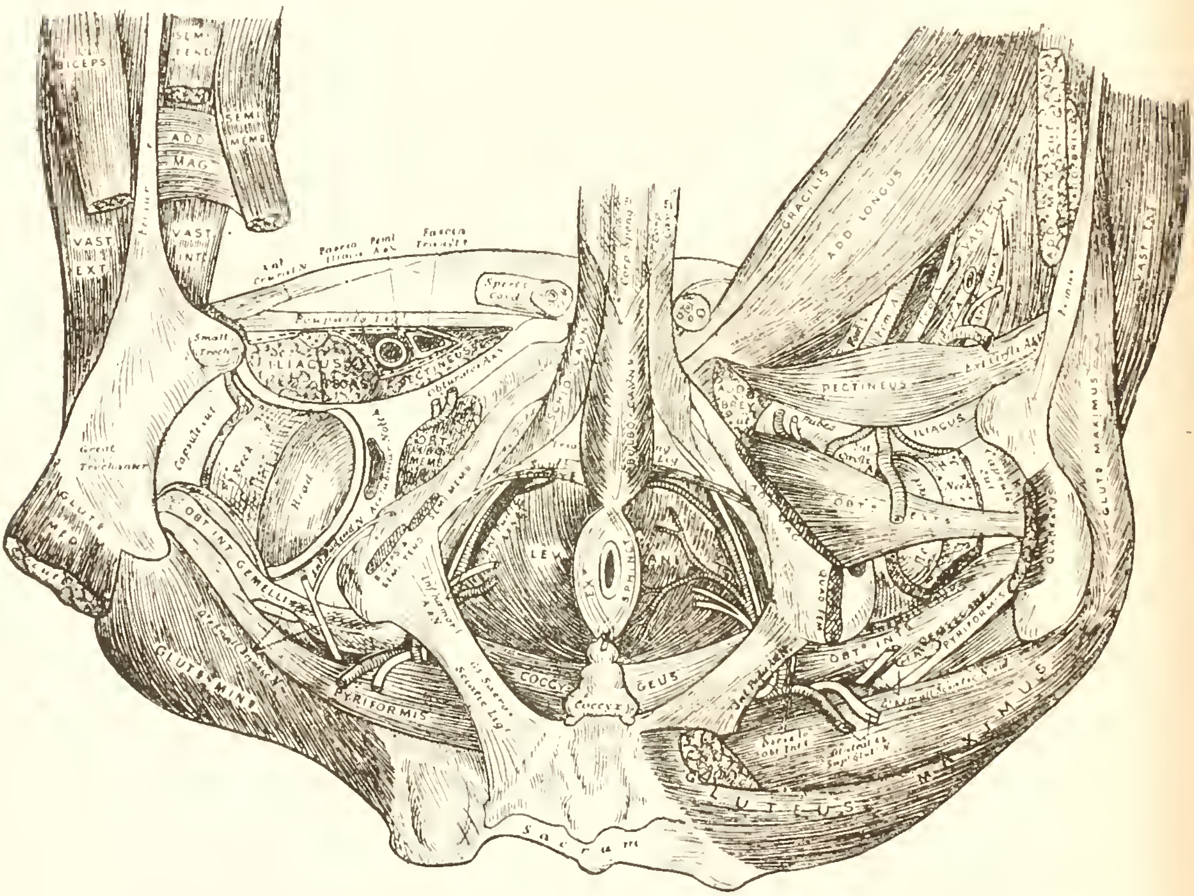


FIG. 491.—DEEP DISSECTION OF THE MALE PERINÆUM AND GLUTEAL REGION.

The dissection has been carried deeper on the right side of the subject.

while it is placed between the crus penis and the pubic ramus. It pierces the crus obliquely, and runs forward in the corpus cavernosum by the side of the septum pectiniforme, supplying it and the erectile tissue of the bulb.

The Dorsal Artery of the Penis is, in size and direction, the continuation of the pudic. It runs up between the crus and pubic symphysis and pierces the suspensory ligament of the penis, running forwards along the dorsum of the penis immediately beneath the skin, parallel with, but external to the dorsal vein. At the glans penis it divides into two branches which supply the glans and prepuce. It supplies the skin of the

penis and fibrous sheath of the corpus cavernosum, anastomosing with the deep arteries. It will be dissected with the external organs of generation.

Variety.—Tiedemann gives a drawing of a case in which this vessel arose from the deep femoral artery, and passed obliquely up and in to reach the root of the penis. I have seen one instance of this which occurred only on the left side.

Varieties of the Pudic Artery.—It is sometimes small or defective in one or more of its usual branches, in which case an *accessory pudic* is the supplementary vessel which remedies the defect. The *Accessory Pudic* may be given off from the anterior division of the internal iliac, or more commonly from the pudic itself, before the latter leaves the pelvis through the great sacro-sciatic foramen. It pierces the triangular ligament after having run along the lower part of the bladder and upper part of the prostate, and runs forwards above the membranous urethra to the perinæum, where it gives off the branches usually derived from the pudic, viz. the artery of the bulb, that of the corpus cavernosum, and the dorsal artery of the penis. The accessory pudic sometimes arises from other branches of the internal iliac, and not uncommonly from the prostatic or some other branch of the inferior vesical artery, and a vessel having a similar distribution may come from the *external* iliac through the epigastric or through an irregular obturator.

The most common deficiency is that in which the internal pudic ends

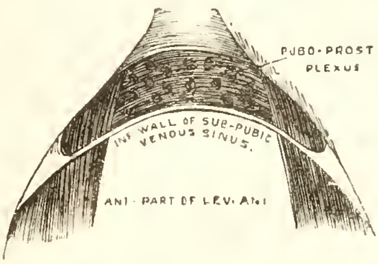


FIG. 492.—SUBPUBIC VENOUS SINUS AND PUBO-PROSTATIC PLEXUS, IN WHICH THE DORSAL VEIN OF THE PENIS ENDS.

as the artery of the bulb. In this case the arteries of the corpus cavernosum and dorsum of the penis are derived from the accessory pudic. But all three arteries to the penis may be supplied by the accessory pudic, the pudic trunk itself ending as the superficial perinæal. Both cavernosus vessels have been given off by a single accessory pudic, whilst the pudic of the right side furnished both dorsal arteries. On the other hand only a single branch has been seen to come from the accessory vessel, that either takes the place of an ordinary branch of the pudic trunk, which may be wanting, or to supplement one of the branches which may be very small.

Two Pudic veins accompany, and have the same relations as the artery, and receive similar branches, except that the dorsal vein of the penis does not join them, but pierces the triangular ligament and divides into two branches which enter the prostatic plexus.

The Pudic Nerve.—The posterior portion of this nerve was dissected with the ischio-rectal fossa. Its anterior part passes along the anterior half of the perinæum, much diminished in size, and between the layers of the

triangular ligament, which it pierces near the pubes, and is continued on the dorsum of the penis with the dorsal branch of the pudic artery. Its termination will be described with the external genitals.

The Corpus Spongiosum and *Deep Perinæal Muscles* are supplied by the perinæal branch of the pudic nerve. Muscular offsets are given off near the base of the triangular ligament, and pass beneath the transversalis muscle, piercing the triangular ligament to supply the muscles between its layers. The nerve of the bulb is a slender long branch supplying the corpus spongiosum. Some of its filaments pass for some distance on the fibrous sheath of the corpus spongiosum before penetrating it to reach the vascular structure in its interior.

Surgical Applications.—The student should replace the triangular ligament and draw the rectum forwards so as to occupy its natural position. The position of the various parts in regard to the incision required in the lateral operation of cutting for stone should now be studied. This operation is generally executed on the left side of the perinæum, this being more convenient for a right-handed operator, but the structures divided will be similar should the operation be done on the right side. A grooved staff having been previously introduced into the bladder, and the stone struck, the patient is tied in the lithotomy position, i.e. in the position the subject was placed in for the dissection of the perinæum. The first incision should begin midway between the back of the scrotum and the anus, about an inch and a half in front of the latter and slightly to the left of the raphé. It is carried obliquely back and out to midway between the anus and ischial tuberosity. This cut divides the skin and superficial fascia, the inferior hæmorrhoidal vessels and nerves, and the superficial and transverse perinæal vessels may also be divided. In the deeper incision the knife is introduced into the anterior portion of the wound and the base of the triangular ligament, the deep transverse perinæal muscle, the posterior fibres of the accelerator urinæ, the anterior part of the levator ani, the constrictor urethræ, and involuntary circular fibres and mucous lining of the urethra will be divided before the knife can enter the groove of the staff. As the knife is pushed along the staff into the bladder, it divides the membranous portion of the urethra, and about an inch of the left lobe of the prostate gland with the anterior venules of the prostatic plexus of veins. The knife is then withdrawn in a direction down and out from the urethra, and partly through the left lobe of the prostate above the level of the ejaculatory duct.

In this operation the following parts *must not be wounded*, and may usually be avoided by attending to the following instructions. The first incision should not be made too near the mid-line, lest the bulb of the corpus spongiosum or the rectum be wounded; nor should it extend too far externally, lest the pudic artery should be injured. If the deep incision be too far forward the artery to the bulb may be divided, and if it extend too far backwards the whole length of the prostate and neck of the bladder may be cut through, and this would allow the urine to infiltrate into the loose cellular tissue between the bladder and rectum and behind the pelvic fascia, instead of permitting its free external escape. From the unhealthy nature of the urine, due to the inflammation of the mucous lining of the bladder set up by the presence of the calculus, diffused

inflammation may be excited in the cellular tissue and give rise to peritonitis by contiguity of the recto-vesical pouch of the peritoneum.

In infants and children it is possible to wound the pudic vessels near the anterior part of the fossa, where they are near the base of the triangular ligament; but posteriorly they are lodged beneath the obturator fascia under cover of the tuber ischii and ischial ramus. Should the artery to the bulb be given off sooner than usual it will cross the front of the ischio-rectal fossa and must almost necessarily be wounded. The incision of the prostate should not usually extend beyond the front of the base of the gland, so as to avoid wounding the recto-vesical fascia which separates the pelvis from the perinæum. It should, however, be stated that some operators prefer a free deep incision, because the stone is more readily extracted, because less injury is done to the neck of the bladder through attempts to dilate the prostate and its fibrous sheath, and also because the external incision being free and dependent, there is little fear but that the urine will flow out through the wound. The *accessory pudic artery*, when present, may be, and has been wounded, in some cases causing immediate or subsequent death from hæmorrhage, and in others giving great trouble to secure it, and causing the patient a long and exhausting convalescence.

In elderly people the prostatic plexus of veins is enlarged, and gives rise occasionally to troublesome hæmorrhage.

Dissection.—Divide the central point of the perinæum and the fibres of the levator ani which descend upon the sides of the prostate to the rectum, and draw the gut towards the coccyx, at the same time drawing the penis and scrotum well up on the staff. The under surface of the membranous urethra and of the prostate, the neck and part of the base of the bladder, with the vasa deferentia and vesiculæ seminales, will be exposed and should be cleaned. These parts will be studied in another dissection, but the student should now make himself quite familiar with their feel and relations.

Directions.—Fasten together the skin flaps after sprinkling salt freely over the parts that have been dissected, then unfasten the limbs, which are to be placed in the positions proper for their dissection, and the structures of the abdominal wall should then be examined.

THE FEMALE PERINÆUM.

In the female there are more differences in the external configuration of the parts than in the internal structure.

External Anatomy.—In the mid-line there is the aperture of the vagina, on either side of which are the labia minora and majora. From the clitoris which is situated at the upper part (see fig. 493), two membranous folds which pass down and out are the labia minora; below the clitoris is the meatus of the urethra, and lower still is the orifice of the vagina, which is in maidens commonly closed by a thin membrane of variable shape called the hymen.

The student should note the mons veneris, which is usually covered with hairs, which grow in a triangular manner, the base of the triangle being above, while in the male the pubic hair tapers up to the umbilicus.

There are few exceptions to this rule. The glans and frænula of the clitoris, the vestibule which is between the urethra and vagina, the carunculæ myrtiformes which surround the lower half of the vaginal orifice, and which are corrugated vascular folds of mucous membrane and may be seen in infants and children, but which were for a long time supposed to be the remains of the ruptured hymen, should also be examined. The fourchette or frænulum pudendi is a small transverse fold, which is usually lacerated in the first labour, and is placed just within the posterior commissure, and the space between it and the commissure is called the *fossa navicularis*. Between the posterior commissure and the anus is the perinæal space. The anus is situated somewhat farther back than in the male.

The bony and ligamentous limits of the perinæum and the contents

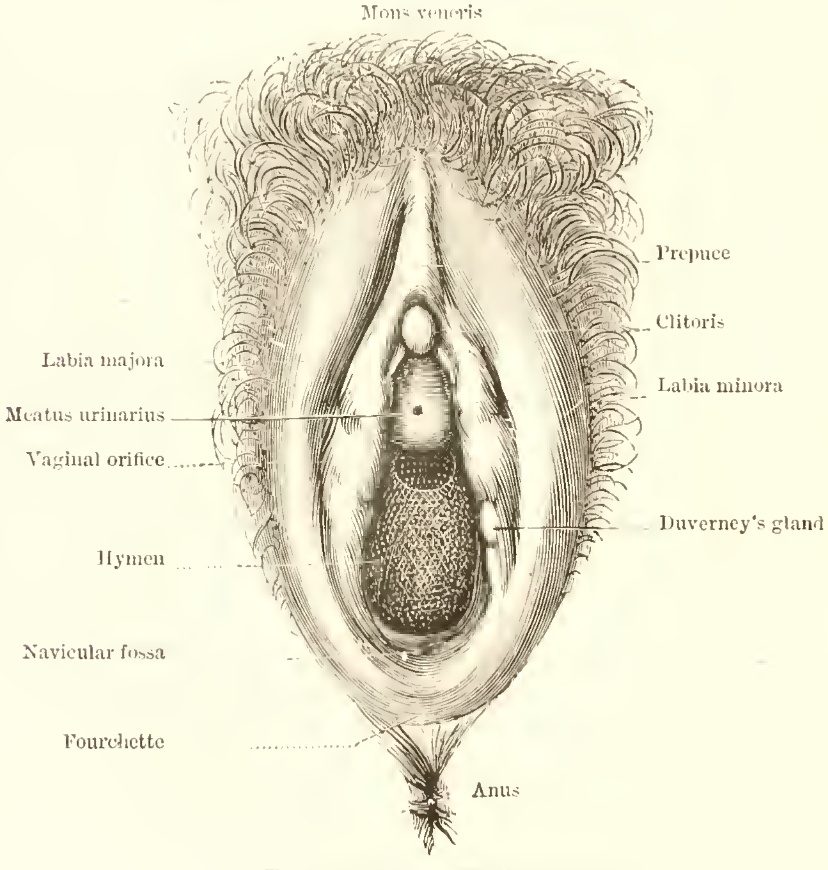


FIG. 193.—THE EXTERNAL FEMALE GENITALS.

and boundaries of the ischio-rectal fossæ are similar in both sexes, but the pelvic outlet is larger in the female.

Dissection.—The rules given for the dissection of the male perinæum will apply for the most part to the female. The posterior part and ischio-rectal fossa being first examined, then the anterior, in the dissection of which a transverse incision should be made in front at the anterior part of the vulva. (The term *vulva* or pudenda is applied to the external female genitals as a whole.) The attachment of the superficial fascia and the cutaneous vessels and nerves are to be made out.

Superficial Fascia.—In the female this is interrupted in the mid-line by the orifice of the vagina, and is consequently of less extent, and its

superficial layer passes forwards through the labia majora (which are analogous to the two halves of the scrotum) to the groins, the mons veneris and around the anus. The deep layer, which is more membranous, is attached laterally to the rami of pubes and ischium, so that if bloody, serous, or purulent effusions be extravasated beneath it they may pass up on to the abdomen, back around the anus, but not into the thighs; and if fluid be effused between the superficial and deep layers it may pass into all the surrounding regions. In the deep layer there is a serous cavity occupied by the round ligament, this is surrounded by a thickish layer of cellulo-fatty tissue which is continuous with that which lines the inguinal canal. Broca has named this cavity the *dartoic sac*, as it is surrounded by white elastic fibres very like those of the male dartos.

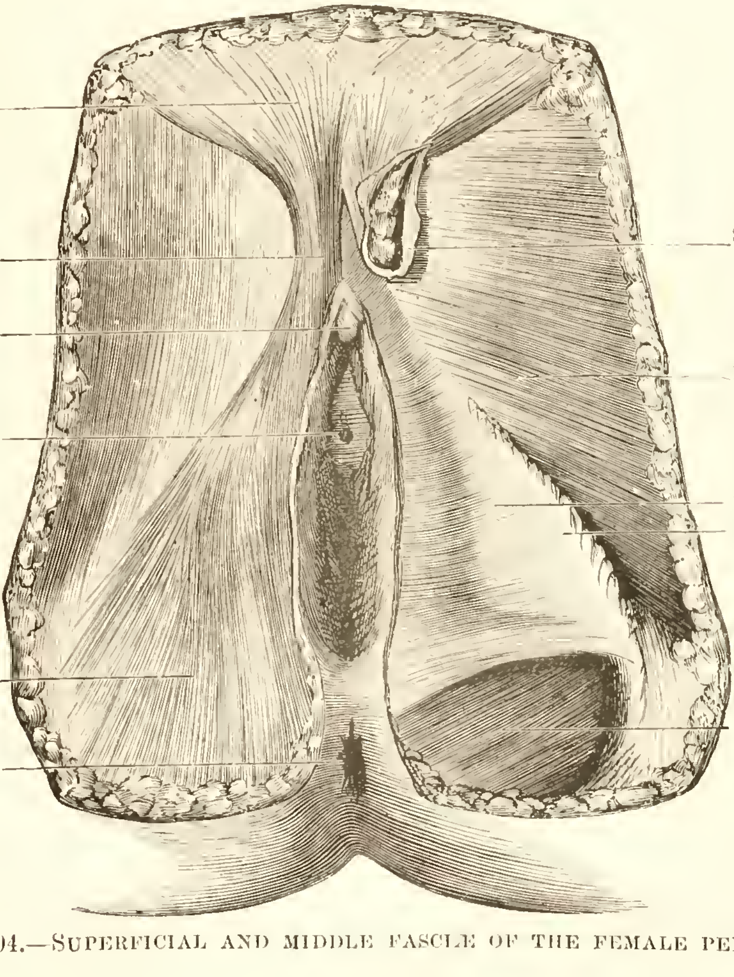


FIG. 494.—SUPERFICIAL AND MIDDLE FASCIÆ OF THE FEMALE PERINÆUM.

Dissections.—Remove the superficial fascia and labia majora, and define the sphincter muscle surrounding the vaginal orifice. In this dissection the transversus perinæi and erector clitoridis, which are arranged like those in the male but are smaller, will be exposed.

The **Sphincter vaginæ** corresponds to the ejaculator urinæ in the male. It surrounds the vaginal orifice, and is an elliptical orbicular muscle attached posteriorly to the central point of the perinæum where it blends with the sphincter ani and transverse perinæi muscles. Its fibres expand to surround the orifice of the vagina and vestibule, embracing on the outer

side the two vestibular bulbs. In front they become narrow and approach each other, and are inserted on the corpora cavernosa of the clitoris, a fasciculus passing over these and enclosing the venæ dorsalis.

Action.—This resembles that of other orbicular muscles, and diminishes the vaginal orifice. Its action is, however, in most subjects feeble. But in certain diseased conditions there is great spasm of this muscle, to which the term *vaginismus* is applied. It also assists in fixing the central perinæal point.

Dissections.—Remove the outer fibres of the sphincter and detach the

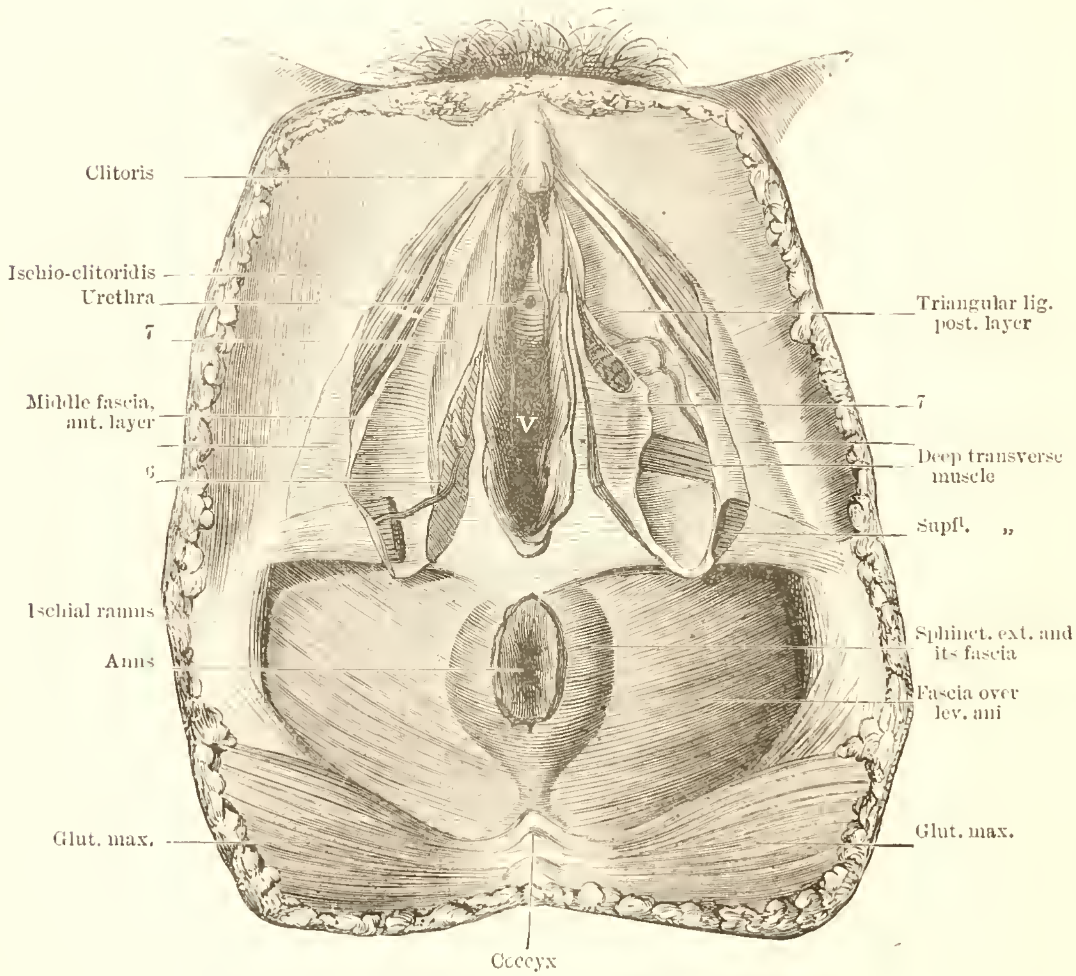


FIG. 495.—DEEPER FASCIA OF FEMALE PERINÆUM.

Vagina. 5, 6, and 7. Superficial perinæal fascia cut. The transverse perinæal artery is shown and the muscle is cut. Beneath 3 is the posterior layer of the triangular ligament or middle fascia.

crus and erector clitoridis from the pubic ramus to see the triangular ligament.

The *subpubic fascia or triangular ligament* is not so strong as in the male, and is perforated by the urethra. It is partly interrupted behind by the vaginal aperture.

Dissection.—Remove the superficial layer of this fascia, as in the male, to expose the deep muscles and pubic vessels and nerves and their branches. The description given in the dissection of the male perinæum will serve for these structures, with the following exceptions:

The **deep transverse muscle** (*depressor urethræ of Santorini*) corresponds to part of the constrictor urethræ of the male. It has similar connections to its corresponding muscle in the male, but Santorini described it as passing above instead of below the urethra.

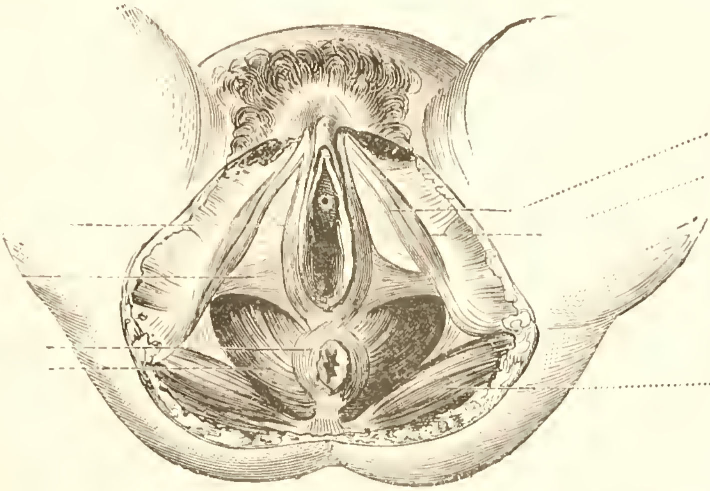


FIG. 496.—SUPERFICIAL MUSCLES OF THE FEMALE PERINÆUM.

The obturator fascia is seen between the levator ani and tuber ischii. The origins of the muscles from the pubic and ischial rami are shown.

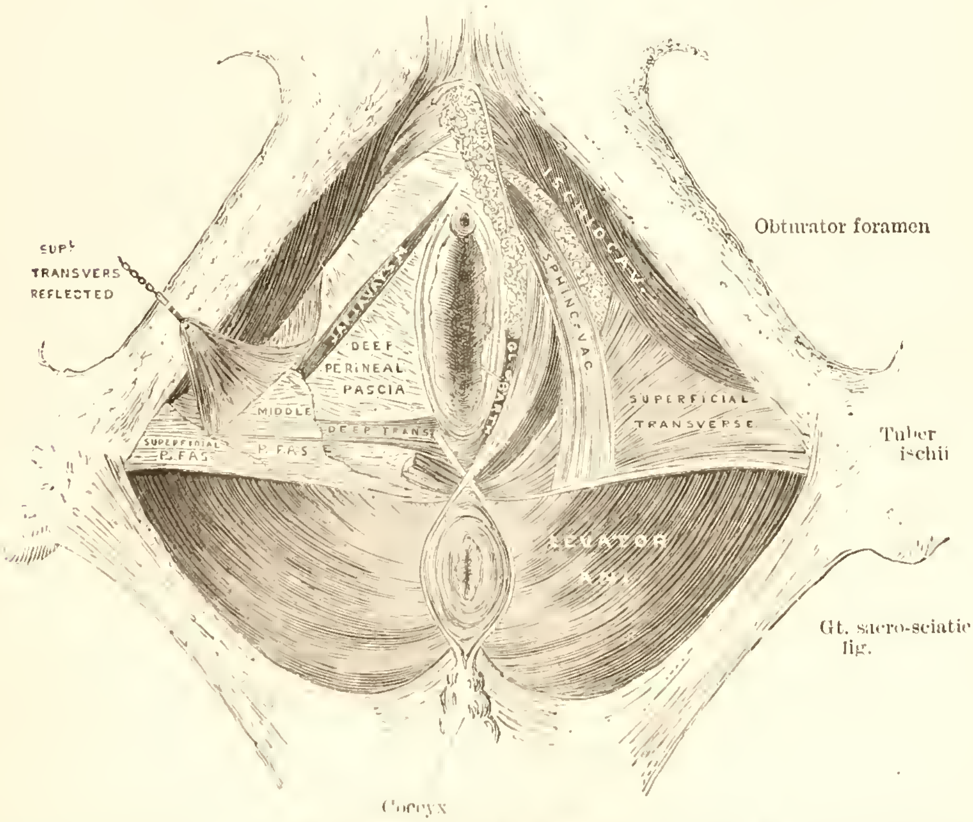


FIG. 497.—DISSECTION OF MUSCLES OF THE FEMALE PERINÆUM, SUPERFICIAL ON LEFT AND DEEP ON RIGHT.

The vascular tissue of the vaginal bulb is shown on the right side passing from the clitoris outside the urethra to near Bartholin's gland.

The **constrictor urethræ** resembles that of the male, and there are two muscular fasciculi which correspond to Wilson's muscle and are inserted around the vaginal bulb and at the sides of the urethra.

In the female the anterior fibres of the levator ani embrace the vagina as they do the prostate in the male.

In the female that branch which represents the artery of the bulb in

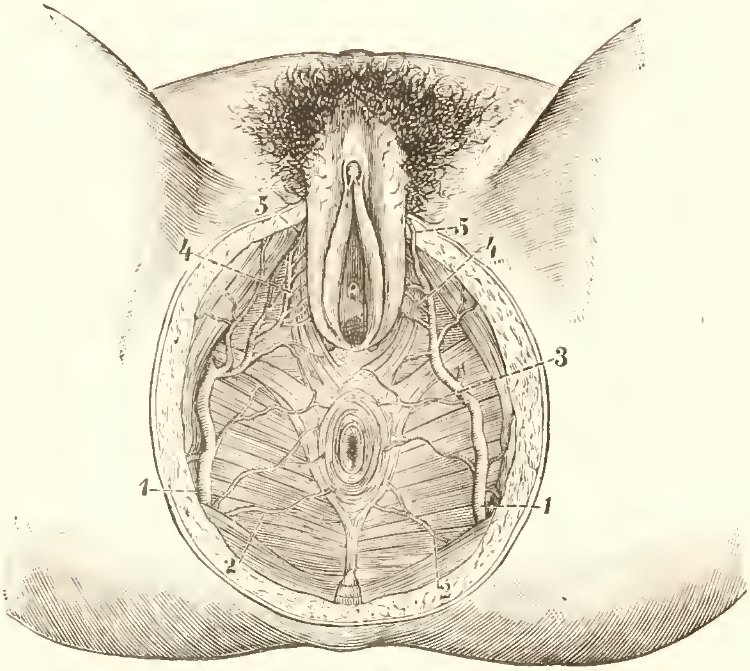


FIG. 498.—ARTERIES OF THE FEMALE PERINÆUM

On the right side are the deep and on the left are the superficial. 1. Int. pudic. 2. Inf. hæmorrhoidal. 3. Transverse perinæal. 4. Bulbar. 5. Dorsal of clitoris.

the male goes to supply the vagina, and the terminal branches of the vessel are much smaller than in the male.

The pudic nerve resembles the artery as regards the branch to the vagina and in the smaller size of the ending of the nerve on the clitoris.

SUMMARY OF DISSECTIONS.

MALE PERINÆUM.

ANAL REGION.

1. After reflecting the skin and noting the corrugator cutis, the venous plexus round the anus, and the external sphincter and its attachments, the ischio-rectal fat should be carefully removed from the fossa, but the inferior hæmorrhoidal and posterior perinæal vessels and nerves should be preserved.

2. Define the boundaries of the fossa, which are the gluteus maximus behind, the obturator internus covered by its fascia on the outer side, and the levator ani above and within.

GENITAL REGION.

1. A median incision from the back of the scrotum around the anus to the tip of the coccyx. 2. Transverse ones on the outer and inner side above and below.

2. In the superficial fascia notice the cutaneous vessels and venous plexus around the anus and the superficial perinæal nerves. Dissect out the corrugator cutis and external sphincter. Follow out the dartos and trace the inferior hæmorrhoidal vessels and nerves.

3. Make out the attachments of the deeper layer of this fascia, which will be found to pass below the transversus perinæi and to be continuous with the anterior layer of the triangular ligament. Reflect it to expose the superficial muscles.

4. These are the bulbo-cavernosus in the mid-line, the ischio-cavernosus at the side, and the transversus perinæi, forming the base of the triangle. The vessels and nerves are the superficial perinæal, the long pudendal of small sciatic, and the inferior hæmorrhoidal artery and nerve. Make out the fascia forming the floor of this space and define the corpora cavernosa, the bulb, and spongy part of the urethra.

5. Make out the attachments of the triangular ligament and the structures piercing and in relation with it. Reflect its anterior layer and note the structures between it and the deep layer.

6. The internal pudic artery and nerve and branches, the deep transverse muscle, and Cowper's glands must be dissected.

7. Define the attachments of the posterior layer of the triangular ligament and notice its connection with the pelvic fascia. The levator ani, Wilson's and Guthrie's muscles, and the membranous portion of the urethra, must be defined.

8. The prostate and its venous plexus, and the vesiculæ seminales and vas deferens must be made out, also the recto-vesical layer of the pelvic fascia.

FEMALE PERINÆUM.

It is only necessary to note the differences in the dissection of the two sexes.

1. An incision at the muco-cutaneous junction of the labia majora to the mid-line of the perinæum, then around the anus to the tip of the coccyx.

2. Observe in the superficial fascia vessels and nerves corresponding to those in the male, also the dartoic covering of the labia majora.

3. Dissect the constrictor of the vagina, the vaginal bulb, the vulvo-vaginal glands, and the corpora cavernosa of the clitoris.

4. Observe that the triangular ligament is very little developed, being pierced by the vagina.

5. Follow out the other structures in the two regions as previously described.

Muscles of the Perinæum, and their Vessels and Nerves.

Name	Origin	Insertion	Action	Antagonists	Arteries come from	Veins go to	Nerve	Lymphatics go to
Sphincter ani ext.	Tip of coccyx	Central point of perinæum	Closes the anus	Levator ani, superficial and deep transverse perinæi	Inferior hæmorrhoidal	Inf. hæmorrhoidal	Inf. hæmorrhoidal and branch from fourth sacral	Inguinal glands
Levator ani	Pubes, spine of ischium, and pelvic fascia	Central perinæal point, side of rectum and coccyx	Raises lower end of rectum	Ext. sphincter and coccygeus	The three hæmorrhoidal	Venæ comites	Ano-coccygeal from fourth sacral	Inguinal and lumbar
Transversus perinæi superficialis	Tuber, and ramus of ischium, inner side	Central tendinous point	Stretches the perinæal fascia and helps to raise the anus	Ext. sphincter and coccygeus	The three hæmorrhoidal		Superficial perinæal	Inguinal and lumbar
Transversus perinæi profundus	Tuber, and ramus of ischium, inner side	Central tendinous point	Stretches the perinæal fascia and helps to raise the anus	Ext. sphincter and coccygeus	The three hæmorrhoidal	,,	Superficial perinæal	Inguinal and lumbar
Coccygeus	Spine of ischium	Side of coccyx	Draws coccyx forward and presses on the rectum	Ext. sphincter and coccygeus	The three hæmorrhoidal	,,	Coccygeal	Inguinal and lumbar
Accelerator urinæ or bulbo-cavernous	Central tendinous point and fibrous raphé	Triangular ligament, corpus spongiosum, and corpora cavernosa	Compresses the bulb, corpora cavernosa, and dorsal vein	—	Perinæal	,,	Perinæal	Inguinal and lumbar
Erector penis or ischio-cavernous	Tuber ischii, inner side, and pubic arch	Outer and under surface of crus of clitoris	Assists in maintaining erection by compressing crus	—	Internal pudic	,,	,,	Inguinal and lumbar
Constrictor urethræ	Pubic ramus, triangular lig.	Tendinous raphé above and below the urethra	Compresses the urethra	—	Perinæal	Perinæal	,,	Inguinal and lumbar
Wilson's muscle, or pubo-urethral	Under surface of symphysis	Sub-urethral raphé	Raises and compresses the urethra	—	Int. pubic	,,	,,	Inguinal and lumbar
Sphincter vaginæ	Central perinæal point at insertion of ext. sphincter and transverse muscles	Corpora cavernosa of clitoris	Diminishes vaginal orifice and compresses vestibular bulbs	—	,,	,,	,,	Inguinal and lumbar

APPENDIX.

I. SECTIONS THROUGH THE LIMBS.

II. VASCULAR ANOMALIES.

SECTIONS THROUGH UPPER LIMB.

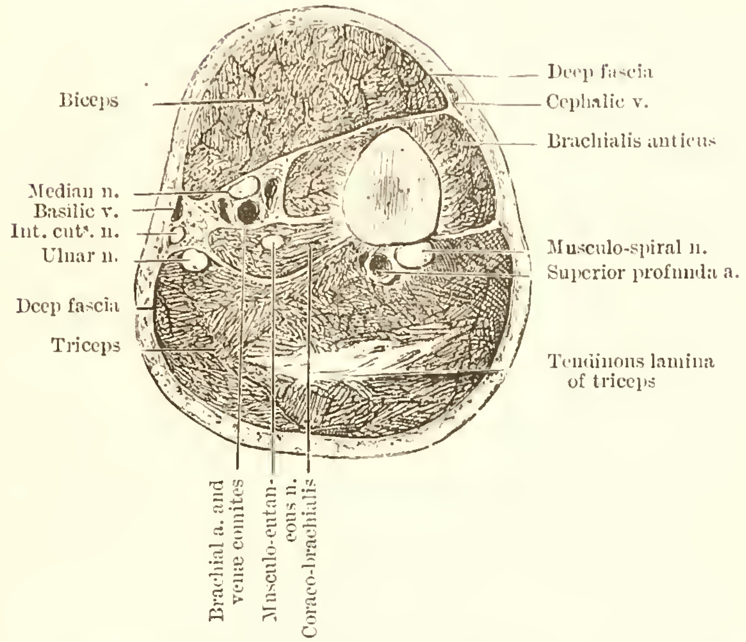


FIG. 499.—TRANSVERSE SECTION THROUGH THE MIDDLE OF LEFT ARM. UPPER PART OF SECTION.

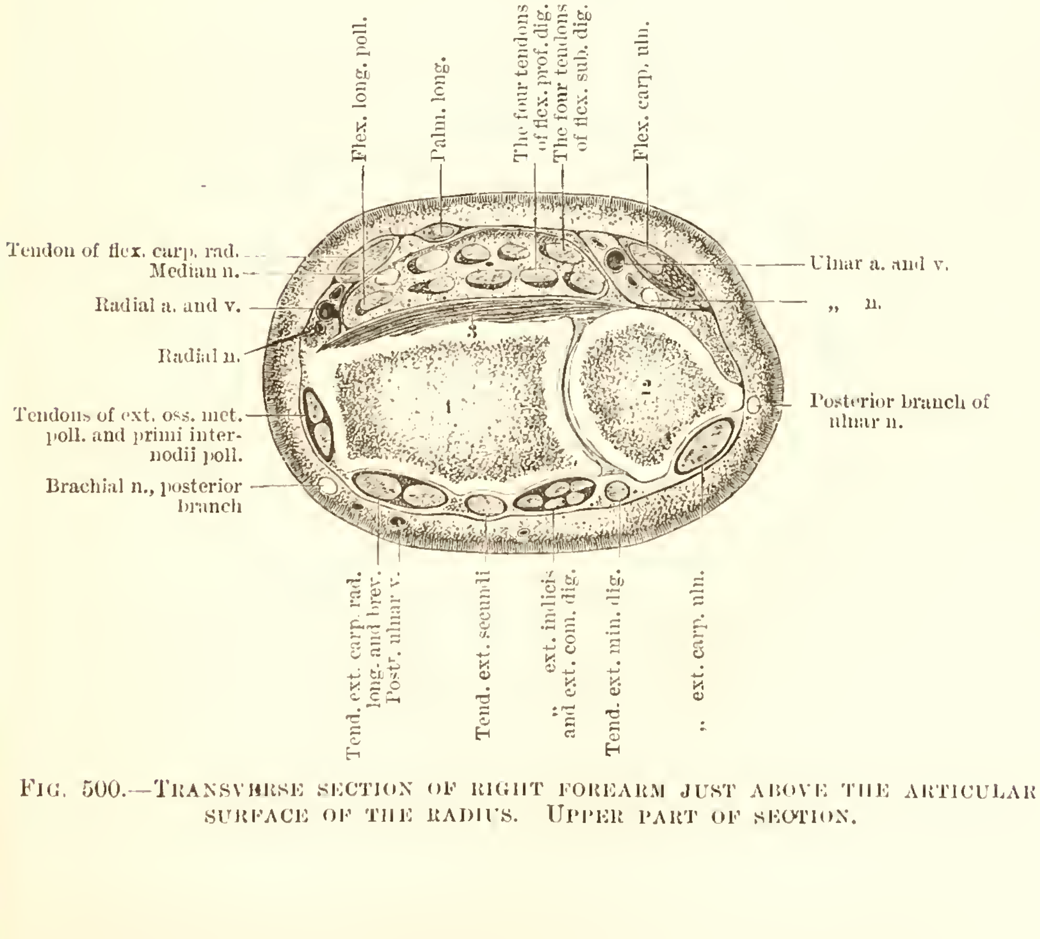


FIG. 500.—TRANSVERSE SECTION OF RIGHT FOREARM JUST ABOVE THE ARTICULAR SURFACE OF THE RADIUS. UPPER PART OF SECTION.

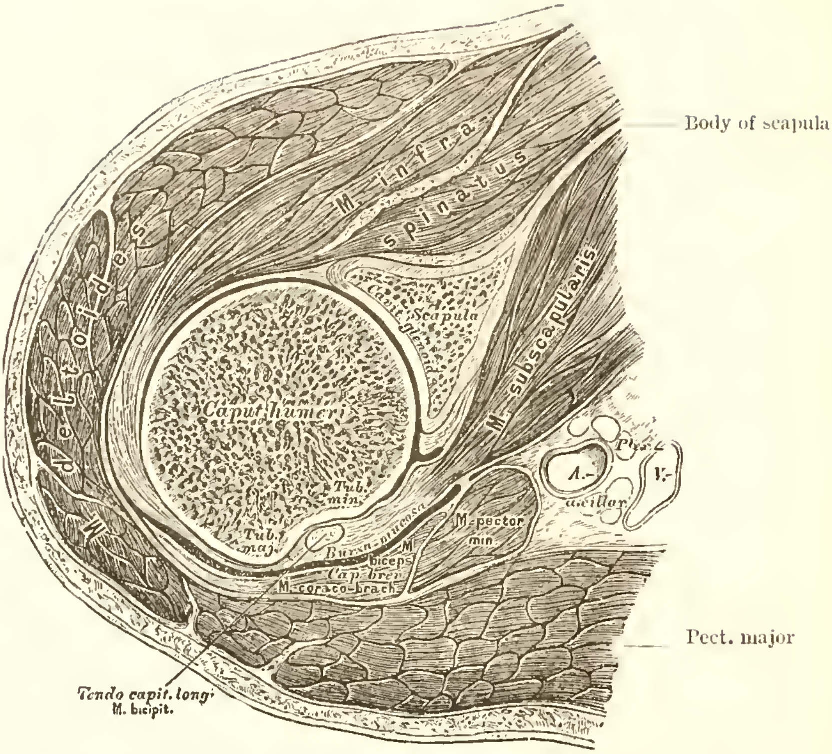


FIG. 501.—ANTERO-POSTERIOR TRANSVERSE SECTION THROUGH THE RIGHT SHOULDER TO SHOW ITS RELATIONS.

SECTIONS THROUGH LOWER LIMB.

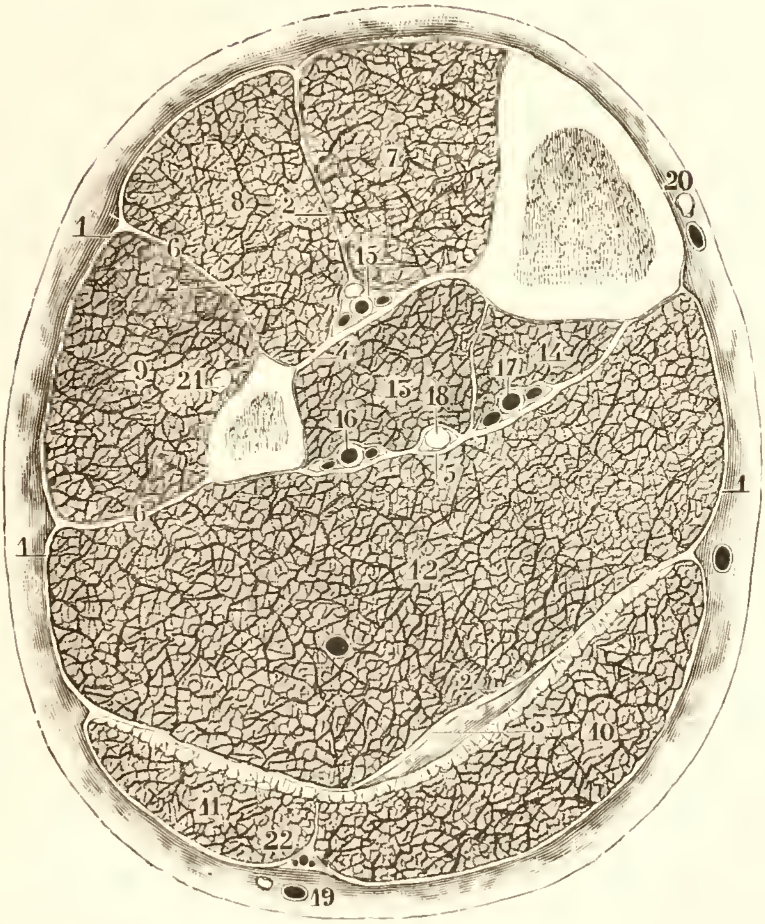


FIG. 502.—TRANSVERSE SECTION OF LEFT LEG AT UPPER THIRD SHOWING THE EXACT RELATIONS OF ALL THE PARTS. LOWER SURFACE OF SECTION (NATURAL SIZE).

1 1 1. Deep fascia. Intermuscular septum between tib. ant. and ext. com. dig.
3. Deep fascia between soleus and gastroc. The thicker whitish line behind it is a section of the tendo-Achillis, and between the two is fatty tissue.
4. Interosseous lig.
5. Septum between soleus and deep muscles.
6 6. Septa between peroneus long. and contiguous muscles.
7. Tibialis anticus.
8. Ext. com. dig.
9. Peroneus long.
10. Inner head of gastroc.
11. Outer head of gastroc.
12. Soleus. A muscular vein is shown cut in its substance.
13. Tibialis posticus.
14. Flex. long. dig.
15. Anterior tib. vessels and nerve.
16. Peroneal vessels.
17. Posterior tib. vessels.
18. ,, nerve.
19. Ext. saphena vein and nerve.
20. Int. ,, ,,
21. Musculo-cutaneous nerve.

A subcutaneous vein is on the right of figure below 1. The vessels are in their sheaths. The section is above the origins of the ext. long. hall. which are not in the figure. The flex. long. hall. should be shown just behind the fibula. The interosseous ligament is shown between the bones.

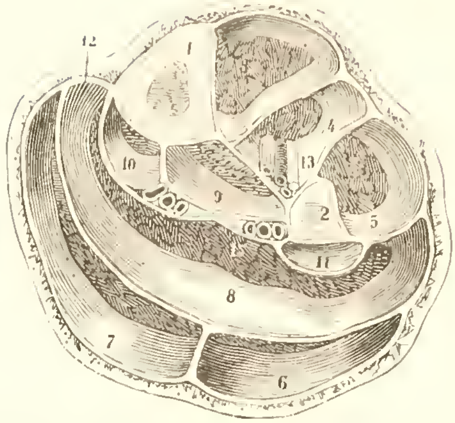


FIG. 503.—TRANSVERSE SECTION THROUGH RIGHT LEG AT UPPER THIRD. LOWER PART OF SECTION.

The intermuscular septa are drawn out to render clearer the muscular sheaths or compartments.

1. Tibia.
2. Fibula.
3. Tibialis anticus.
4. Ext. long. dig.
5. Peroneus long.
6. Outer head of gastroc.
7. Inner head of gastroc.
8. Soleus.
9. Tibialis posticus.
10. Flex. long. dig.
11. Flex. long. hall.
12. Inner border of soleus.
13. Anterior tibial vessels and nerve.
15. Peroneal vessels.

The post. tibial vessels and nerves are in the compartment to the left of these. The external saphenous vein and nerve are not represented, but would be subcutaneous about the position of the white line separating 6 and 7, and the int. saph. vein and nerve would be beneath the skin between the tibia and 12. The section is above the origins of the ext. proprius hall. and peroneus brevis, which are not shown. The interosseous ligament is shown passing between the bones.

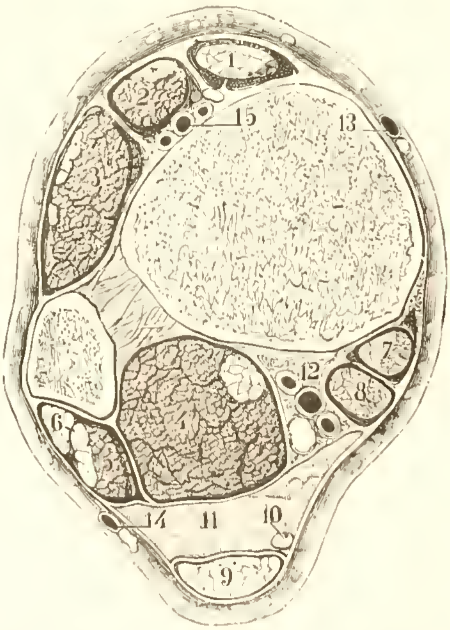


FIG. 504.—TRANSVERSE SECTION OF LEFT LEG JUST ABOVE THE BASES OF THE MALLEOLUS. INFERIOR SURFACE OF SECTION.

1. Tendon of tibialis anticus.
2. Ext. prop. hall.
3. Ext. com. dig.
4. Flex. long. hall.
5. Peroneus brevis.
6. Peroneus long.
7. Tibialis posticus.
8. Flex. long. dig.
9. Tendo-Achillis.
10. Plantaris.
11. Fatty tissue.
12. Sheath of posterior tibial vessels and nerve.
13. Internal saph. vein and nerve.
14. External „ „
15. Anterior tibial vessels and nerve.

This figure gives an exact and clear representation of the relative size of each muscle and tendon, the deep fascia and intermuscular septa. The inferior interosseous ligament is shown in section. The whiter parts of 2, 3, and 4 represent tendons cut.

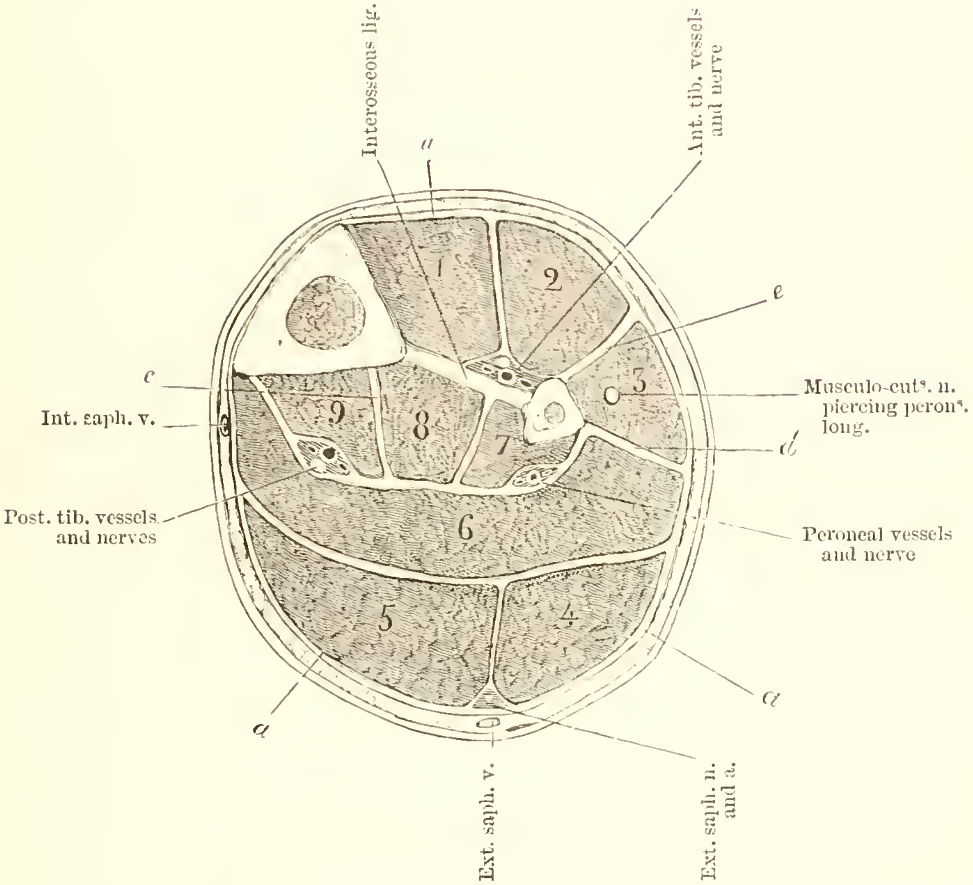


FIG. 505.—DIAGRAM OF A TRANSVERSE SECTION THROUGH RIGHT LEG AT UPPER THIRD TO SHOW THE DISPOSITION OF THE INTERMUSCULAR SEPTA. LOWER SURFACE OF SECTION.

a a a. Deep fascia or aponeurosis.
b, c, d, e. Intermuscular septa.
1. Tibialis anticus.
2. Ext. long. dig.
3. Peroneus long.
4. Ext. head of gastroc.
5. Int. ,, ,,
6. Soleus.
7. Flex. long. hall.
8. Tibialis posticus.
9. Flex. long. dig.

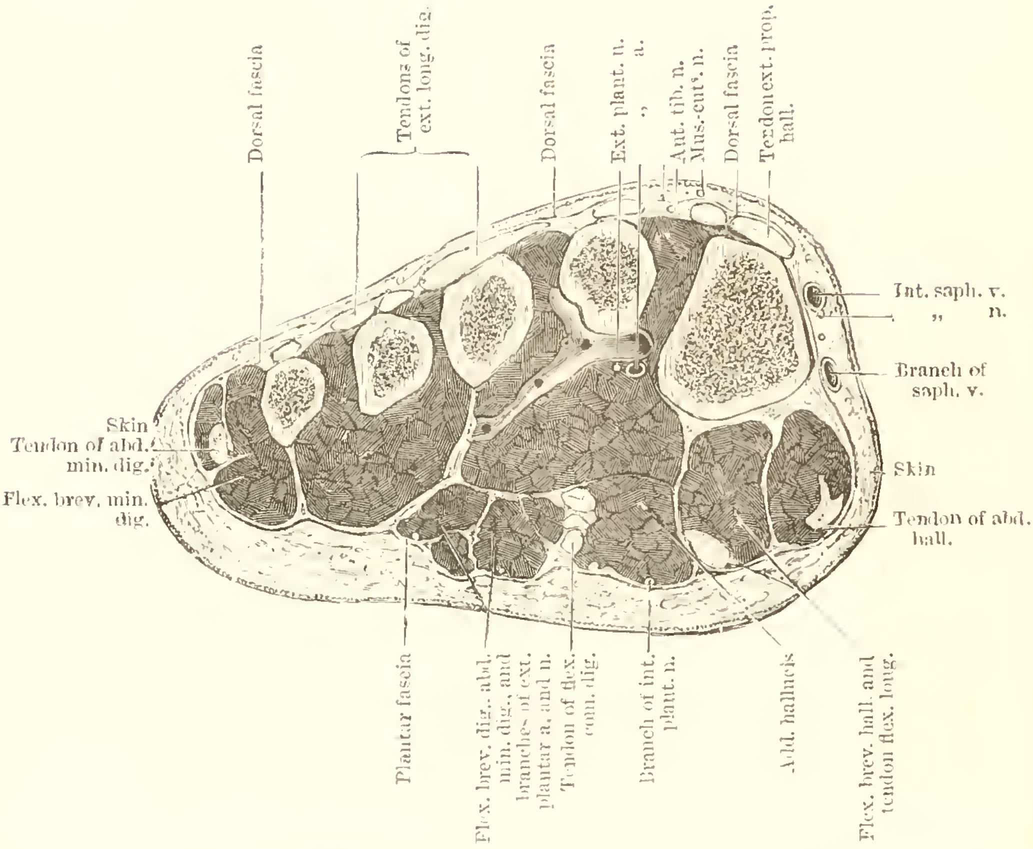


FIG. 506.—TRANSVERSE VERTICAL SECTION OF LEFT FOOT THROUGH UPPER THIRD OF METATARSALS. ANTERIOR SURFACE OF SECTION.

Above 15 and 16 the venous plantar arch is shown opened. The dorsal and plantar interossei are between the bones. The dorsal interosseous arteries are not represented in the figure.

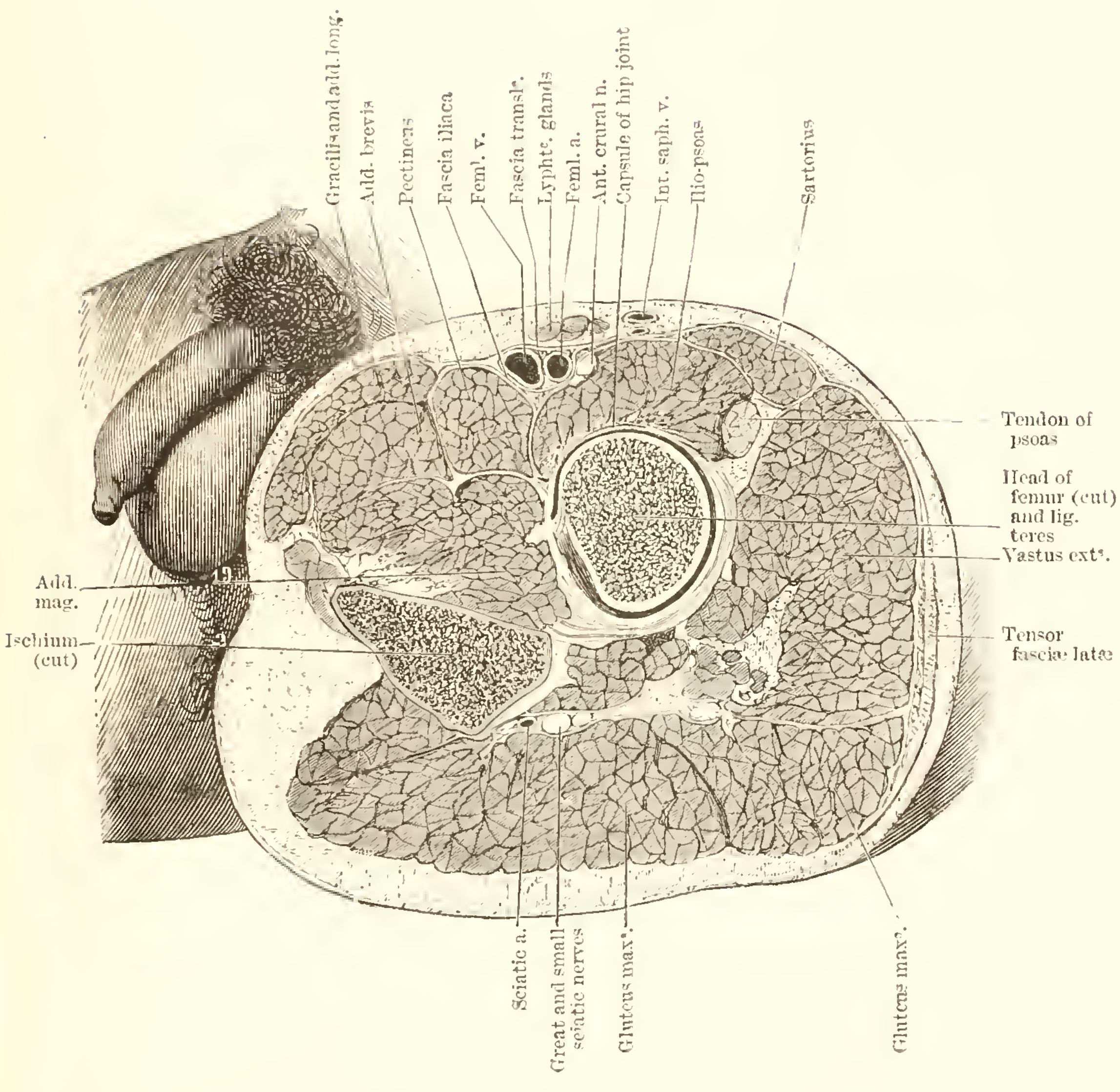


FIG. 507.—VERTICAL TRANSVERSE SECTION THROUGH THE LEFT HIP JOINT PARALLEL TO POUPART'S LIGAMENT, SHOWING THE INTERMUSCULAR SEPTA AND THAT THE HIP JOINT CAPSULE IS THICKER BEHIND AND EXTERNALLY, AND THAT THE SUBCUTANEOUS FAT IS MORE ABUNDANT INTERNALLY AND BEHIND.

ANOMALIES OF ARTERIES OF UPPER LIMB.

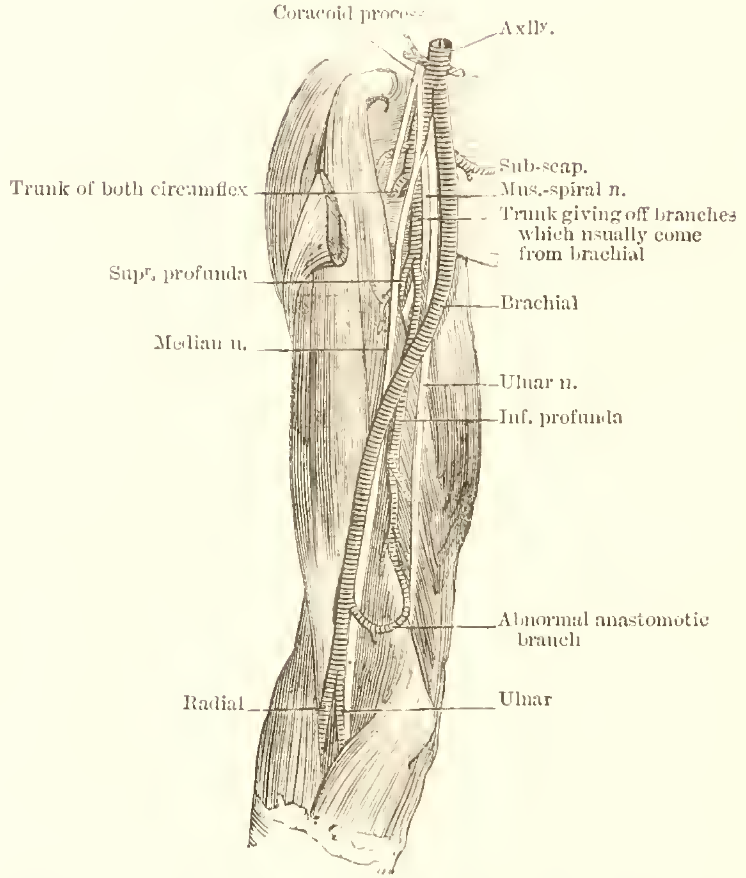


FIG. 508.—ANOMALIES OF THE AXILLARY AND BRACHIAL.

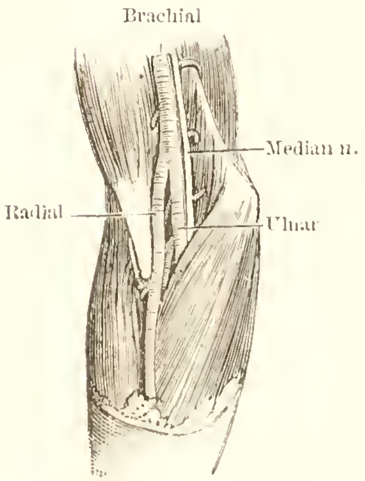


FIG. 509.—ORIGIN OF RADIAL HIGHER THAN USUAL.

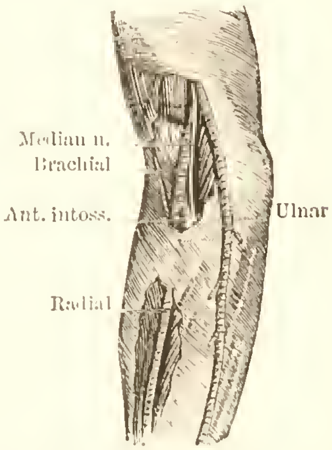


FIG. 510.—HIGH ORIGIN OF ULNAR WHICH IS SUBCUTANEOUS. ANTERIOR INTEROSSEOUS GIVEN OFF WITH RADIAL.

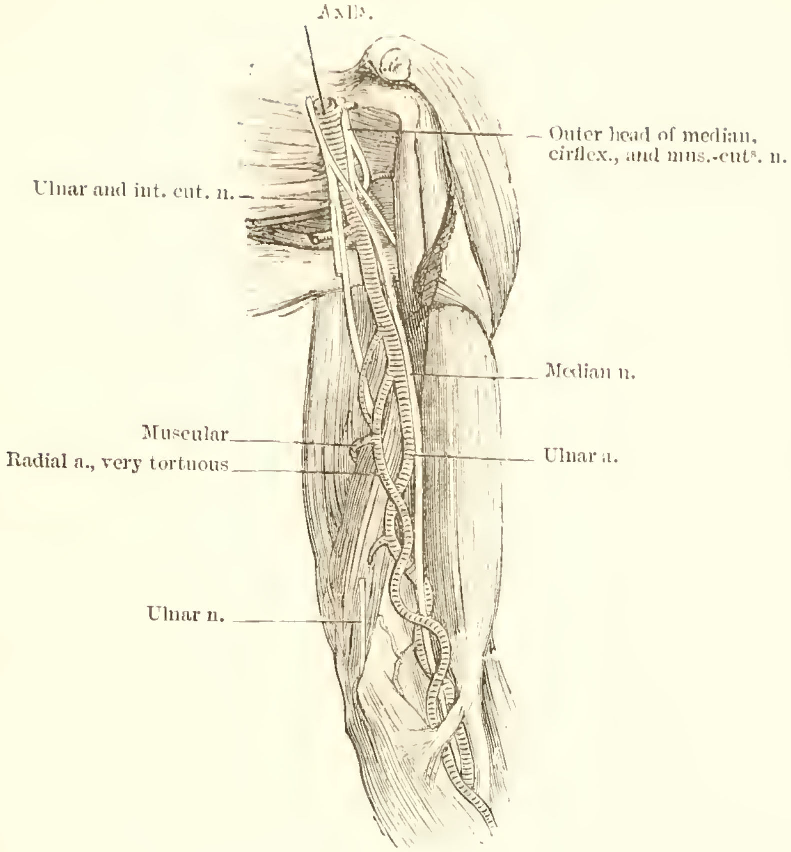


FIG. 511.—HIGH ORIGIN OF RADIAL AND ULNAR.

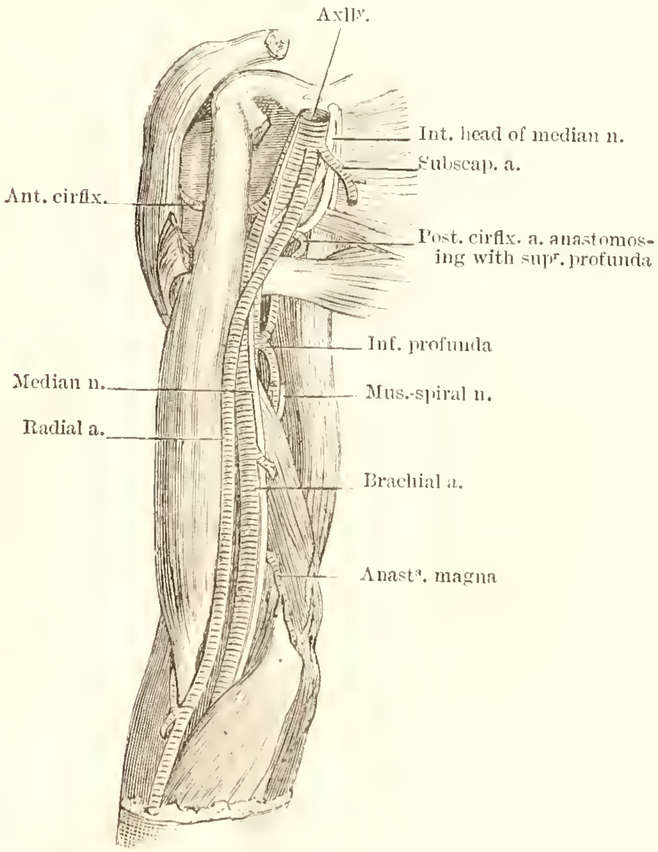


FIG. 512.—ORIGIN OF THE RADIAL FROM THE AXILLARY.

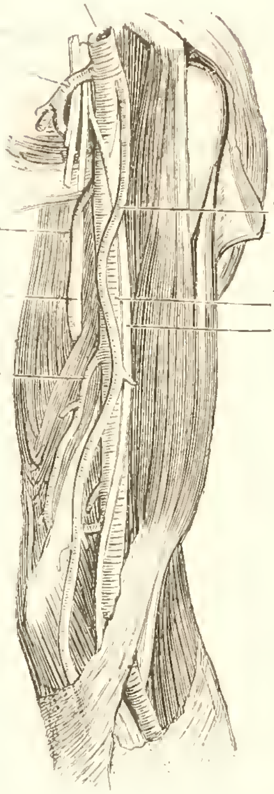


FIG. 513.—ORIGIN OF THE ULNAR FROM THE AXILLARY.

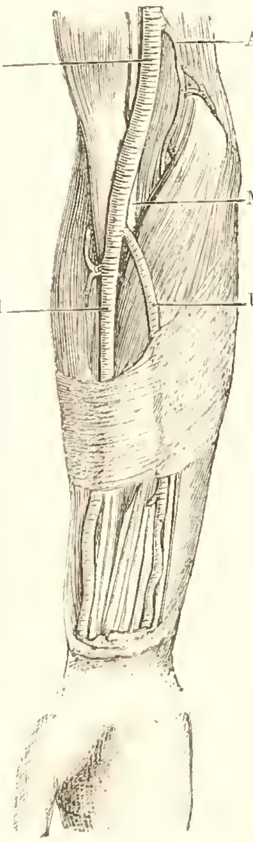


FIG. 514.—LOW DIVISION OF BRACHIAL AND A SUPERFICIAL ULNAR.

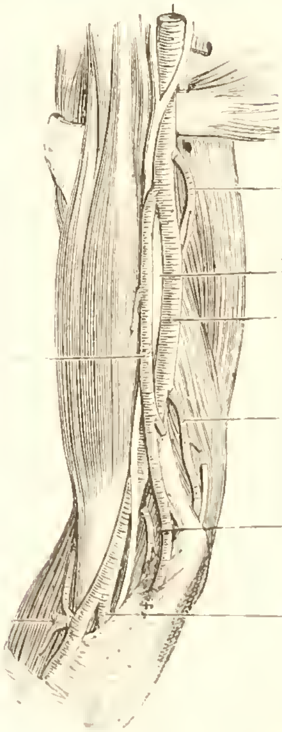


FIG. 515.—ULNAR GIVEN OFF HIGHER UP FROM BRACHIAL.

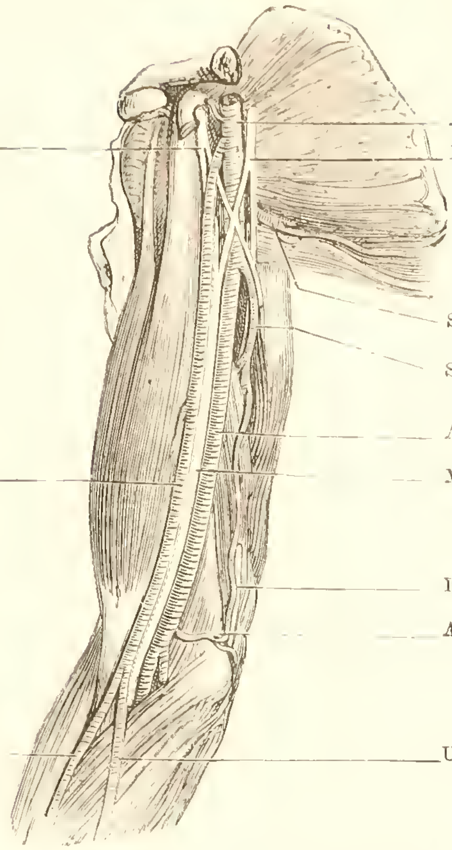


FIG. 516.—ANTERIOR INTEROSSEOUS GIVEN OFF FROM THE AXILLARY.

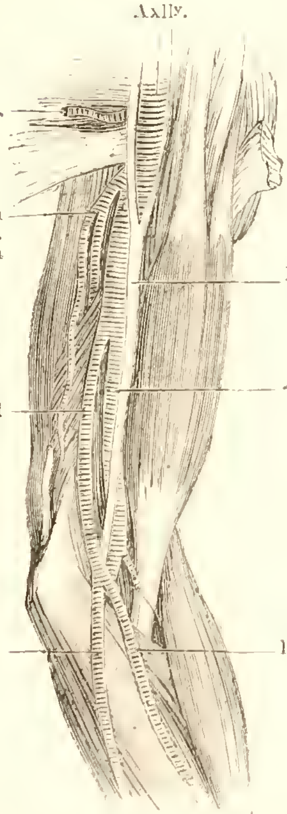


FIG. 517.—ANTERIOR INTEROSSEOUS GIVEN OFF FROM THE BRACHIAL HIGH UP.

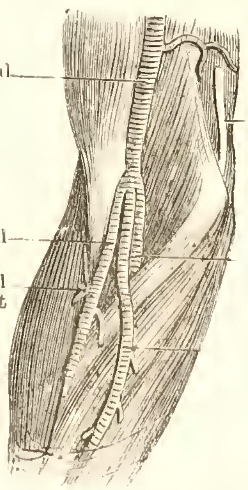


FIG. 518.—ANTERIOR INTEROSSEOUS GIVEN OFF LOWER FROM THE BRACHIAL.

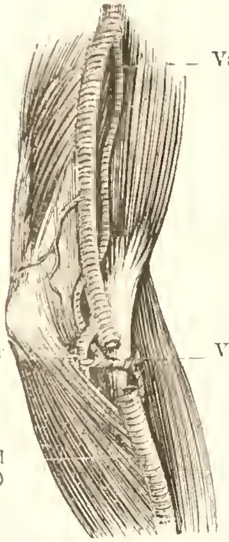


FIG. 519.—BRACHIAL CONTINUED AS A LARGE SUPERFICIAL RADIAL AND VAS ABERRANS.

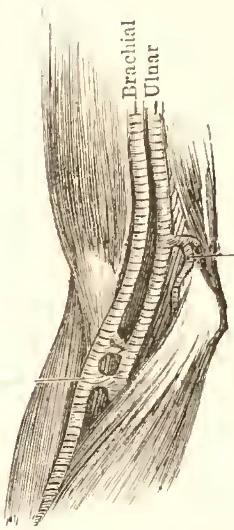


FIG. 520.—HIGH ORIGIN OF ULNAR, BRACHIAL CONTINUED AS RADIAL, TRANSVERSE ANASTOMOTIC BRANCHES.

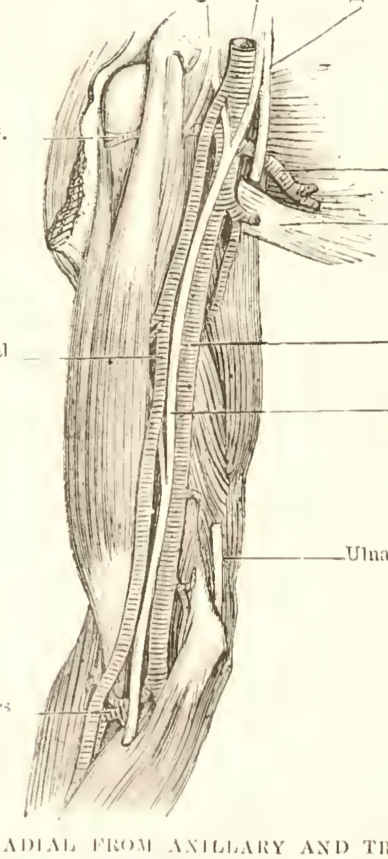


FIG. 521.—ORIGIN OF RADIAL FROM AXILLARY AND TRANSVERSE ANASTOM BRANCHES.

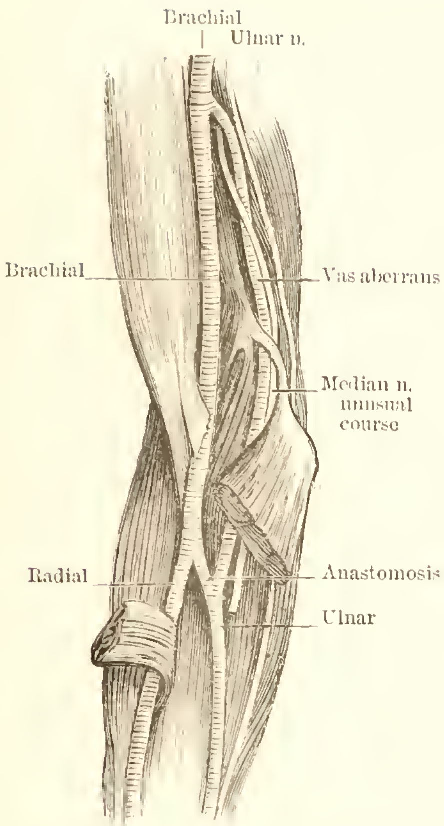


FIG. 522.—RADIAL AND ULNAR NORMAL. VAS ABERRANS JOINING BRACHIAL AND ULNAR.

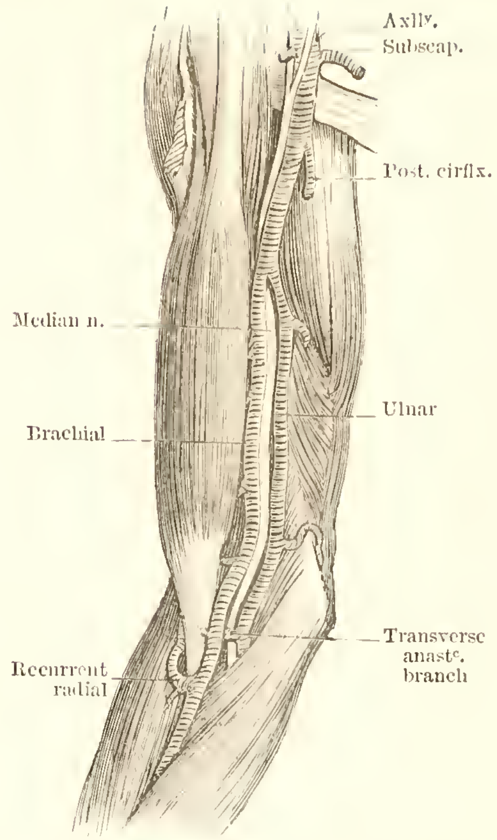


FIG. 523.—HIGH DIVISION OF BRACHIAL.

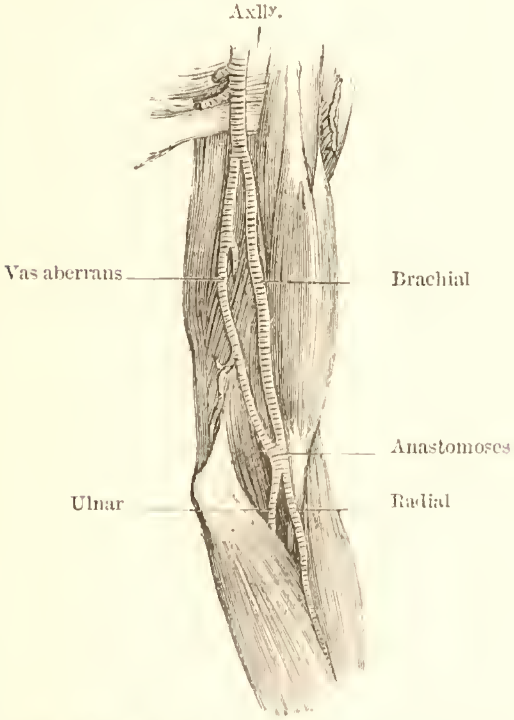


FIG. 524.—A VAS ABERRANS WHICH JOINS BRACHIAL BEFORE RADIAL AND ULNAR ARE GIVEN OFF

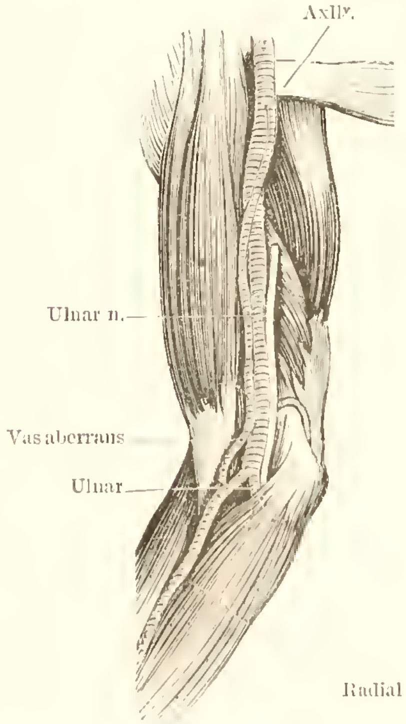


FIG. 525.—VAS ABERRANS JOINING RADIAL AND BRACHIAL.

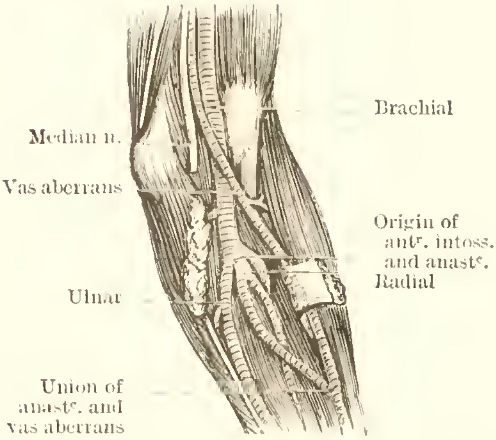


FIG. 526.—UNUSUAL ORIGIN OF ANTERIOR INTEROSSEOUS FROM BRACHIAL BY A COMMON TRUNK WITH AN ABNORMAL ANASTOMOTIC.

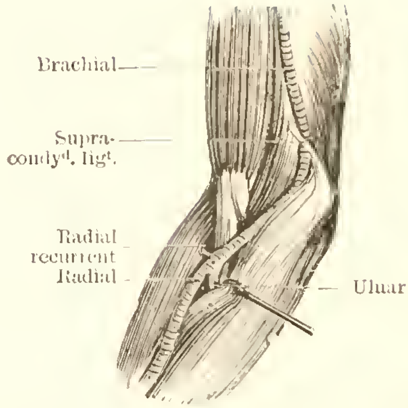


FIG. 527.—BRACHIAL PASSING BENEATH A SUPRACONDYLOID FORAMEN.

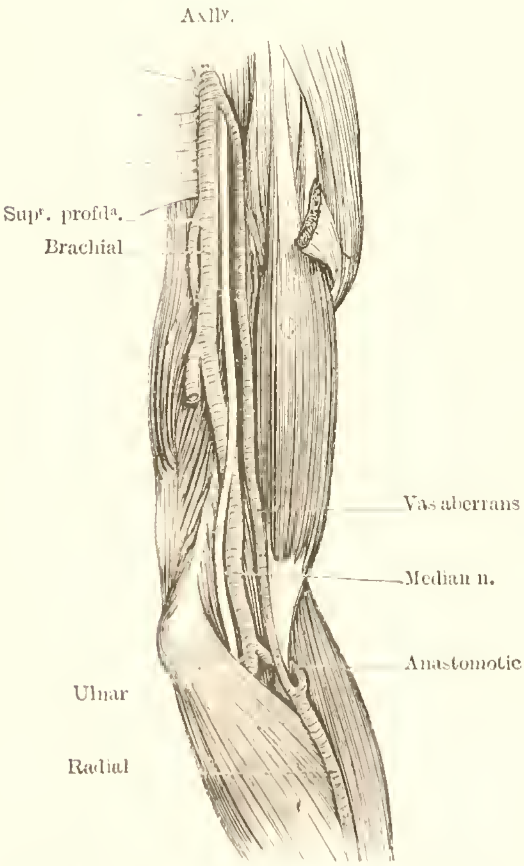


FIG. 528.—RADIAL FORMED BY UNION OF VAS ABERRANS AND ANASTOMOTIC.

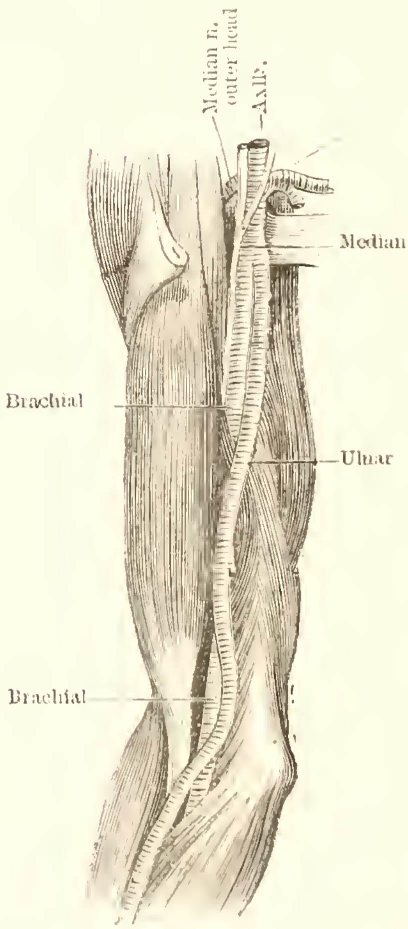


FIG. 529.—RADIAL ARISING FROM AXILLARY AND SUPERFICIAL TO BRACHIAL IN ARM, THE BRACHIAL PIERCING THE BRACHIALIS ANTICUS.

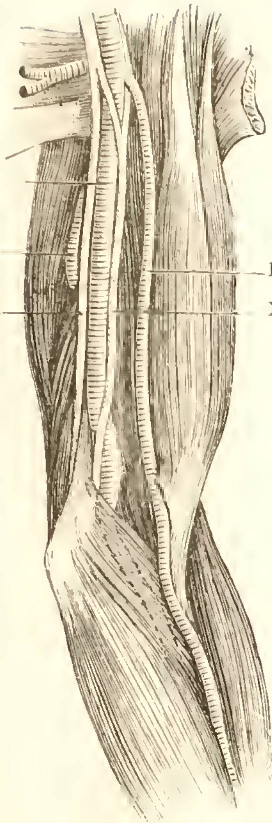


FIG. 530.—A SUPERFICIAL RADIAL GIVEN OFF FROM AXILLARY.

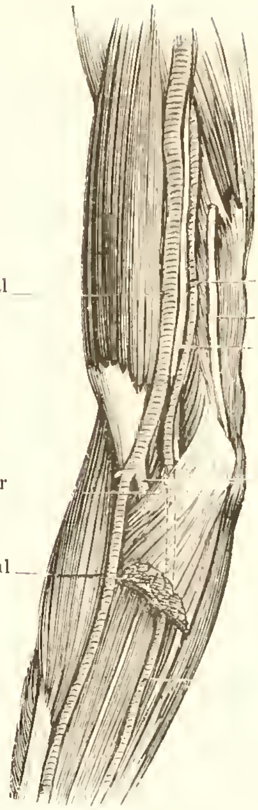


FIG. 531.—ORIGIN OF ULNAR FROM AXILLARY AND A SUPERFICIAL RADIAL.

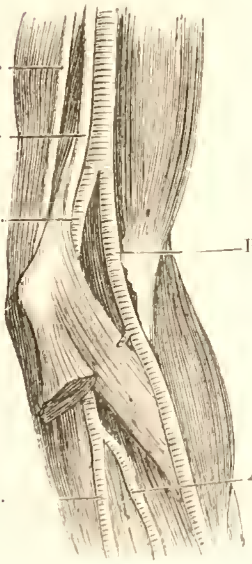


FIG. 532.—UNUSUAL ORIGIN OF ANTERIOR INTEROSSEOUS DIRECT FROM ULNAR AND A SUPERFICIAL RADIAL.

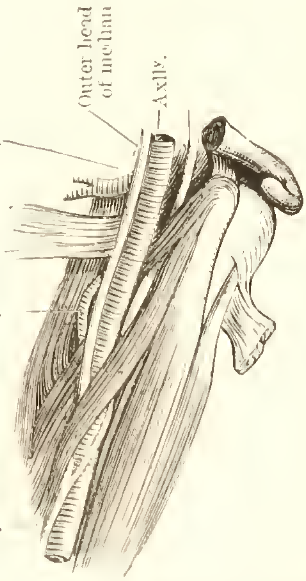


FIG. 533.—BRACHIAL PASSING BETWEEN CORACO-BRACHIALIS AND THE TWO HEADS OF THE MEDIAN WHICH ARE LOW DOWN.

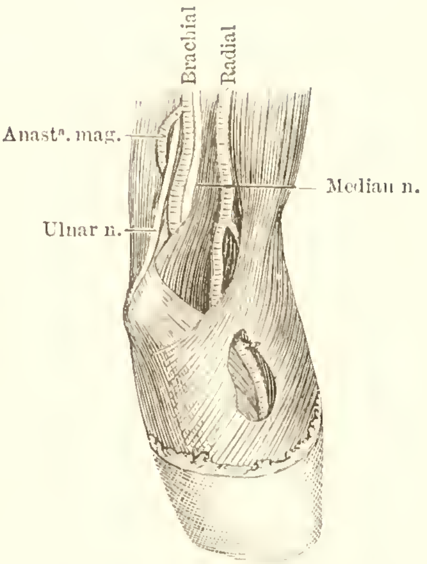


FIG. 534.—A SOMEWHAT SIMILAR ARRANGEMENT TO THE LAST.

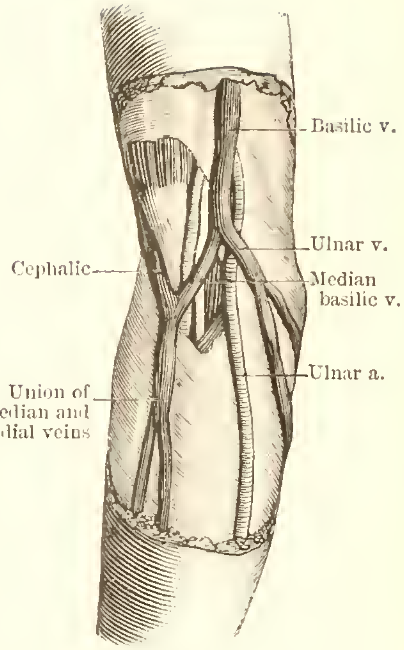


FIG. 535.—HIGH ORIGIN OF RADIAL AND ULNAR, THE LATTER SUPERFICIAL, AND AN UNUSUAL ARRANGEMENT OF THE VEINS.

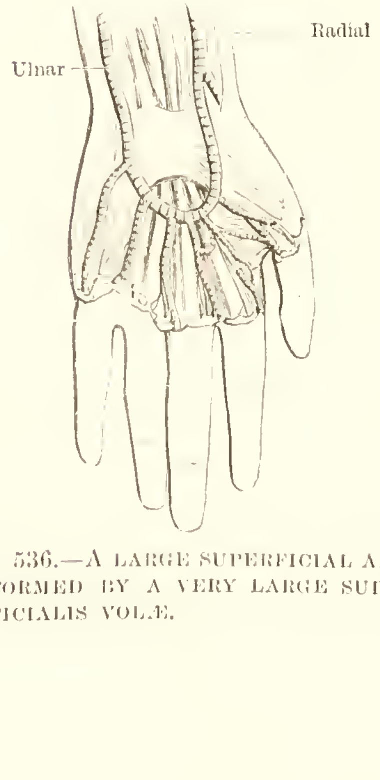


FIG. 536.—A LARGE SUPERFICIAL ARCH FORMED BY A VERY LARGE SUPERFICIALIS VOLÆ.

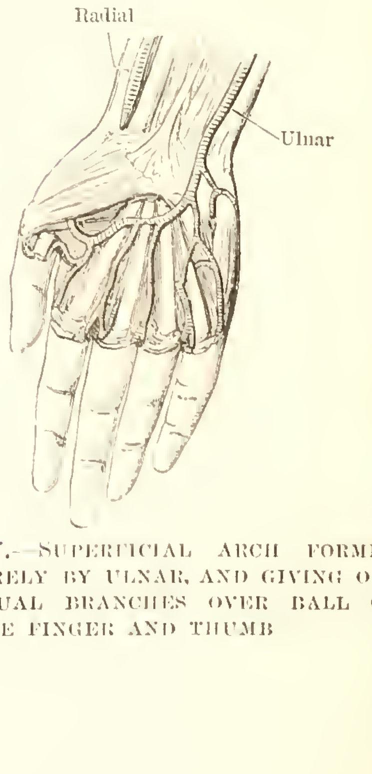


FIG. 537.—SUPERFICIAL ARCH FORMED ENTIRELY BY ULNAR, AND GIVING OFF UNUSUAL BRANCHES OVER BALL OF LITTLE FINGER AND THUMB

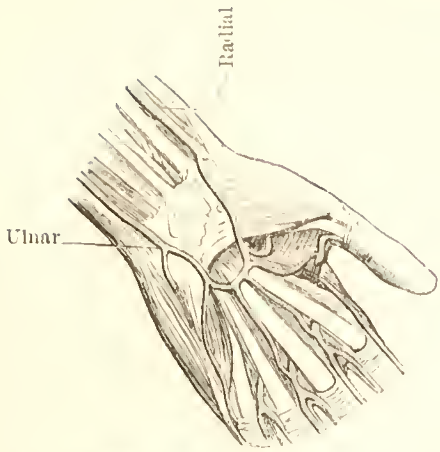


FIG. 538.—A SMALL SUPERFICIAL ARCH, THE DIGITALS JOIN THE INTEROSSEI TO FORM THE COLLATERAL DIGITALS.

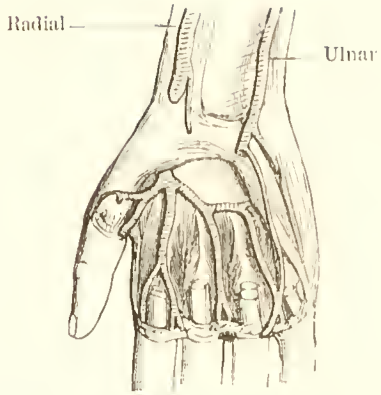


FIG. 539.—LARGE INTEROSSEI OF DEEP ARCH GIVING OFF DIGITALS.

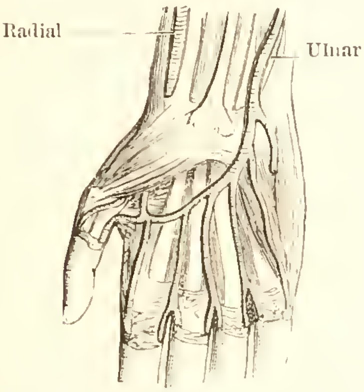


FIG. 540.—SUPERFICIAL ARCH JOINED BY PRINCEPS POLLICIS.

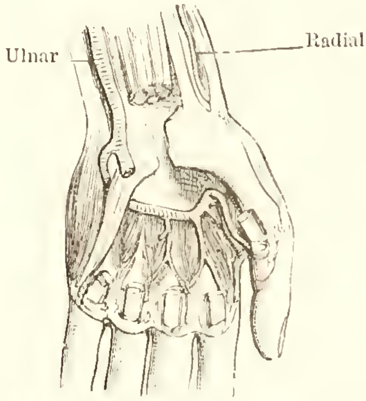


FIG. 541.—DEEP ARCH FORMED BY THE ULNAR, THE RADIAL VERY SMALL.

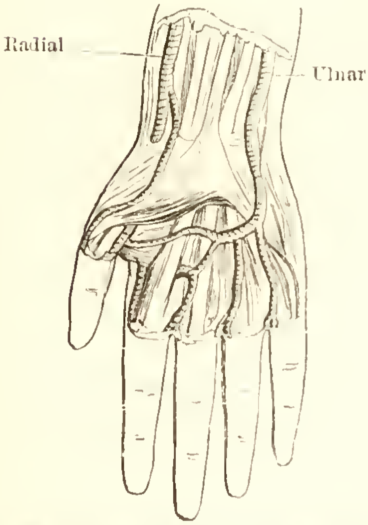


FIG. 542.—SIMILAR TO PRECEDING. A LARGE RADIALIS POLLICIS GIVEN OFF FROM THE RADIAL.

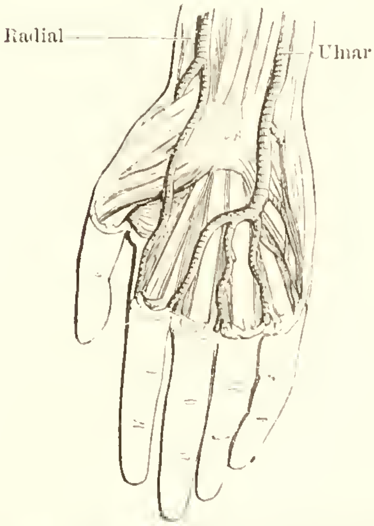


FIG. 543.—SUPERFICIAL ARCH FORMED BY ULNAR, A LARGE SUPERFICIALIS VOLÆ CONTINUED AS THE RADIALIS INDICIS.

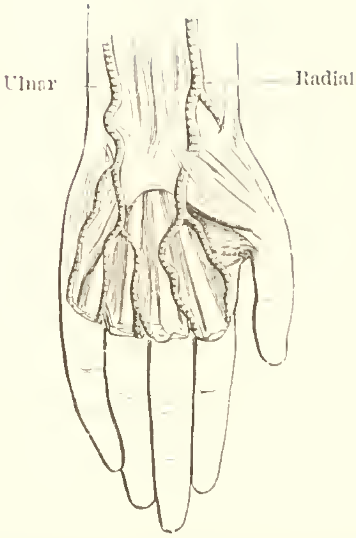


FIG 544.—NO DISTINCT SUPERFICIAL ARCH, THE ULNAR AND A LARGE SUPERFICIALIS VOLÆ REPRESENT IT.

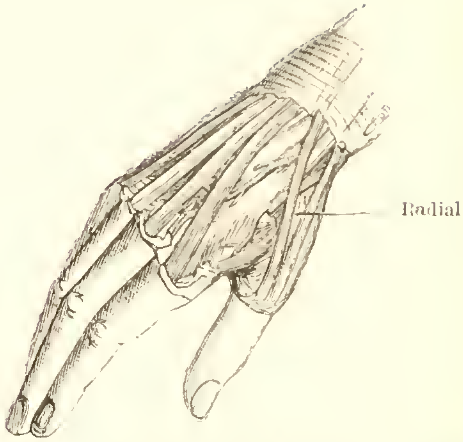


FIG. 545.—LARGE FIRST AND SECOND DORSAL INTEROSSEI.

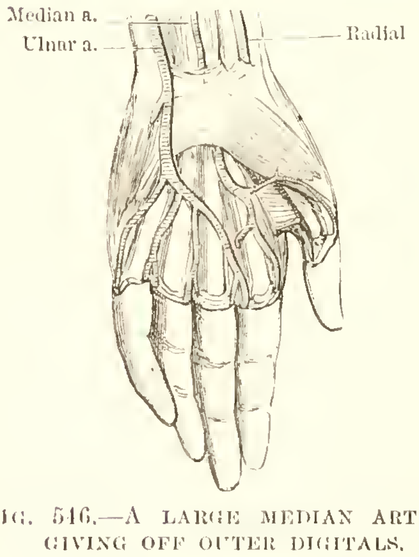


FIG. 546.—A LARGE MEDIAN ARTERY GIVING OFF OUTER DIGITALS.

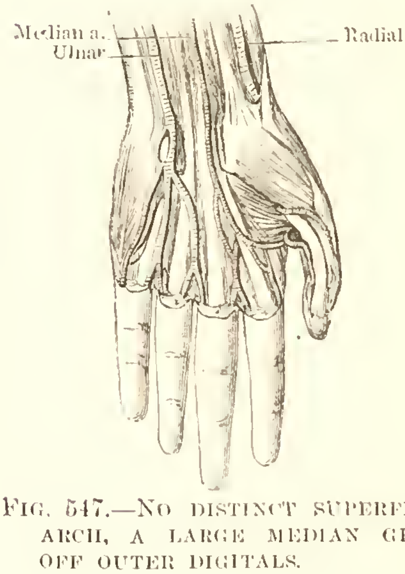


FIG. 547.—NO DISTINCT SUPERFICIAL ARCH, A LARGE MEDIAN GIVING OFF OUTER DIGITALS.

VARIETIES OF VEINS OF UPPER LIMB.

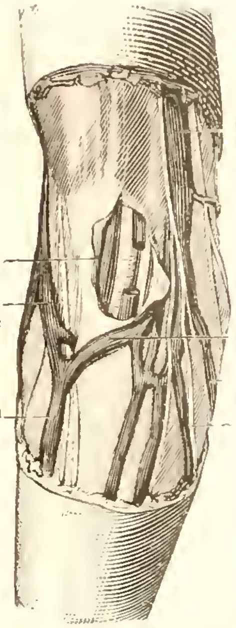


FIG. 548.—SEVERAL ULNAR VEINS.

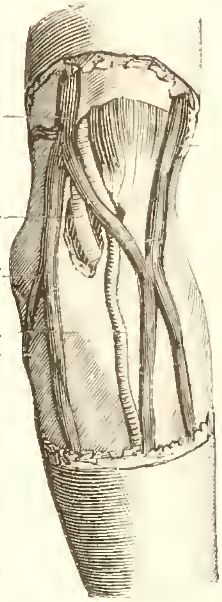


FIG. 549.—FUSION OF MEDIAN AND RADIAL. HIGH DIVISION OF BRACHIAL ARTERY. MEDIAN CEPHALIC ABSENT.

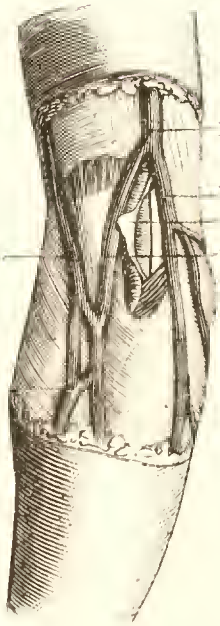


FIG. 550.—MEDIAN BASILIC PARALLEL TO THE SUPERFICIAL RADIAL ARTERY.

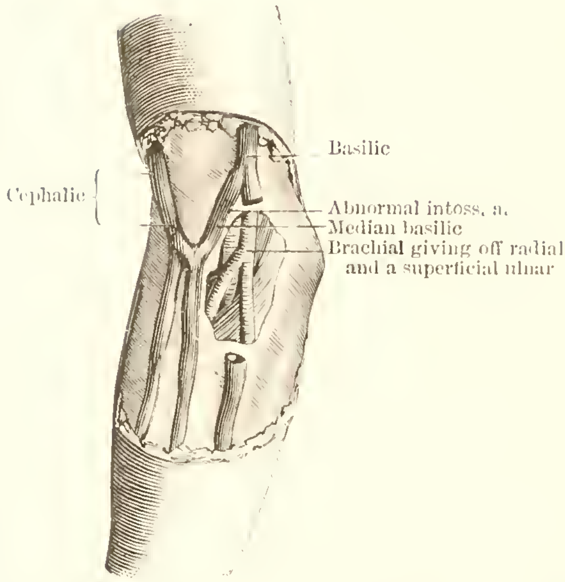


FIG. 551.—THE MEDIAN BASILIC IS EXTERNAL TO THE ARTERIES WHICH ARE ABNORMAL. THE MEDIAN CEPHALIC VERY SMALL.

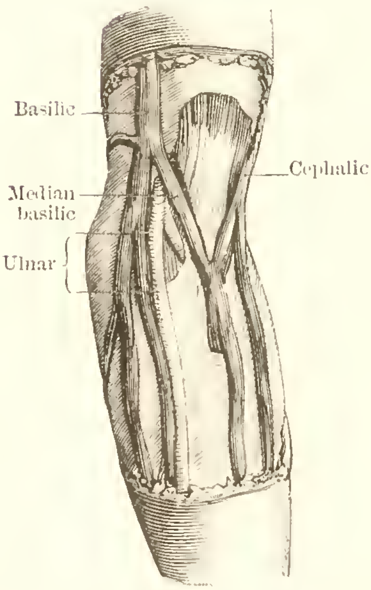


FIG. 552.—SEVERAL ULNAR VEINS, A SUPERFICIAL ULNAR ACCOMPANYING ONE OF THE VEINS.

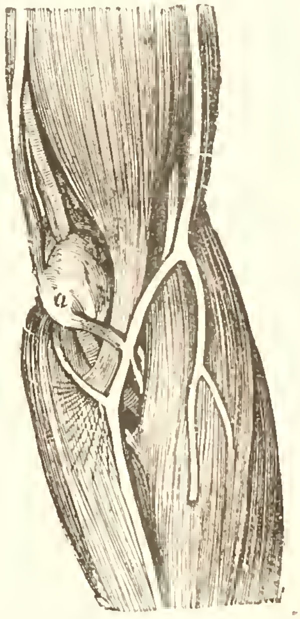


FIG. 553.—THE MEDIAN BASILIC PASSING BEHIND INNER CONDYLE, THE BRACHIAL ARTERY PASSING THROUGH A SUPRA-CONDYLOID FORAMEN.

SOME ARTERIAL VARIATIONS IN LOWER LIMB.

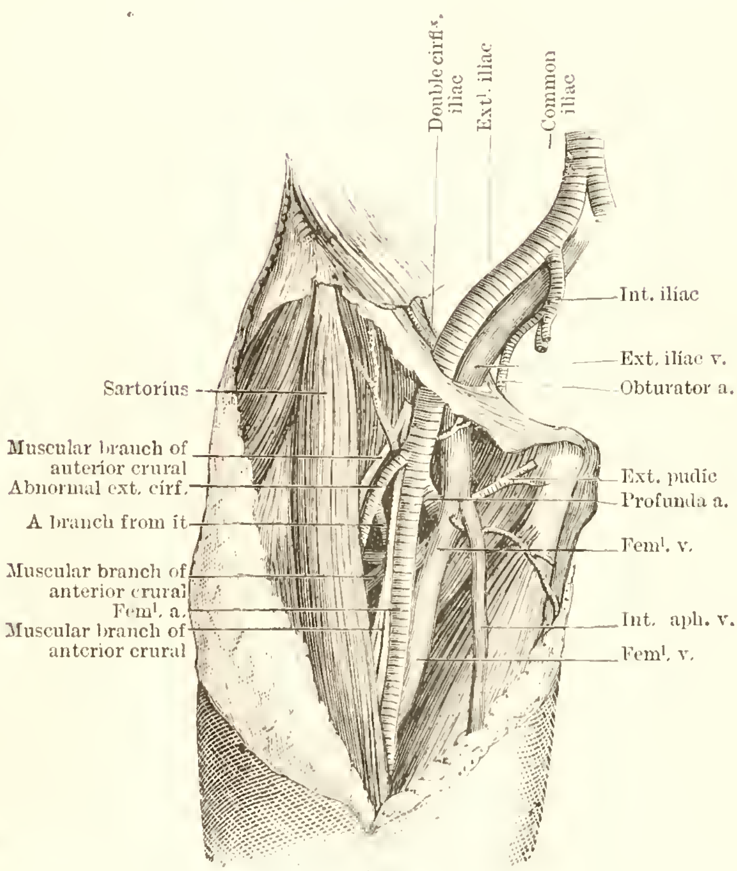


FIG. 554.—VARIETIES IN ORIGINS OF RIGHT EXTERNAL CIRCUMFLEX AND CIRCUMFLEX ILIAC.

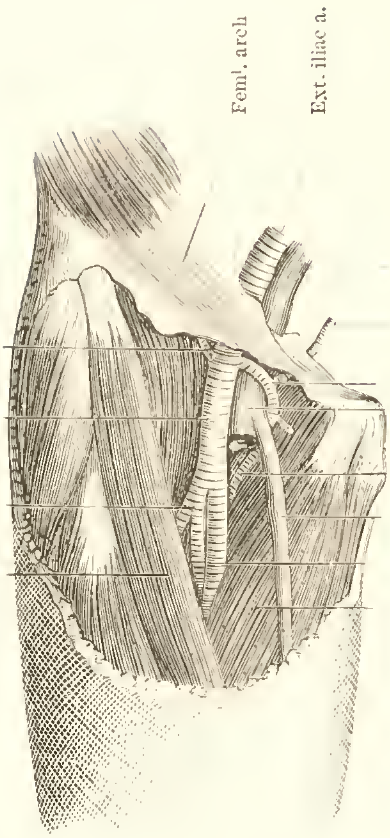


FIG. 555.—ANOMALOUS ORIGIN OF THE RIGHT INTERNAL CIRCUMFLEX. THE PROFUNDA BREAKING UP AT ONCE INTO LARGE BRANCHES.

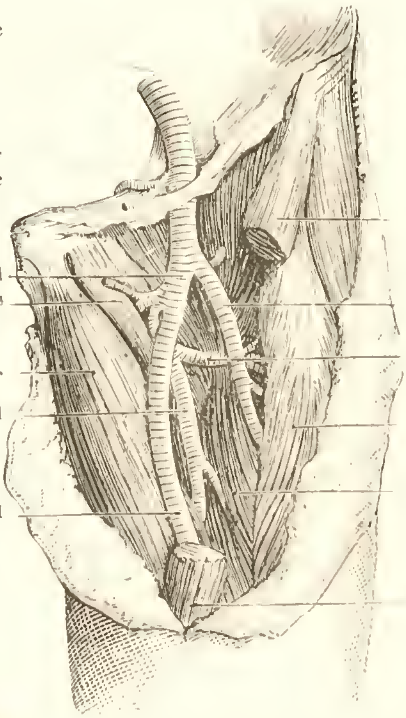


FIG. 556.—UNUSUAL ORIGIN OF THE OBTURATOR AND EXTERNAL CIRCUMFLEX.

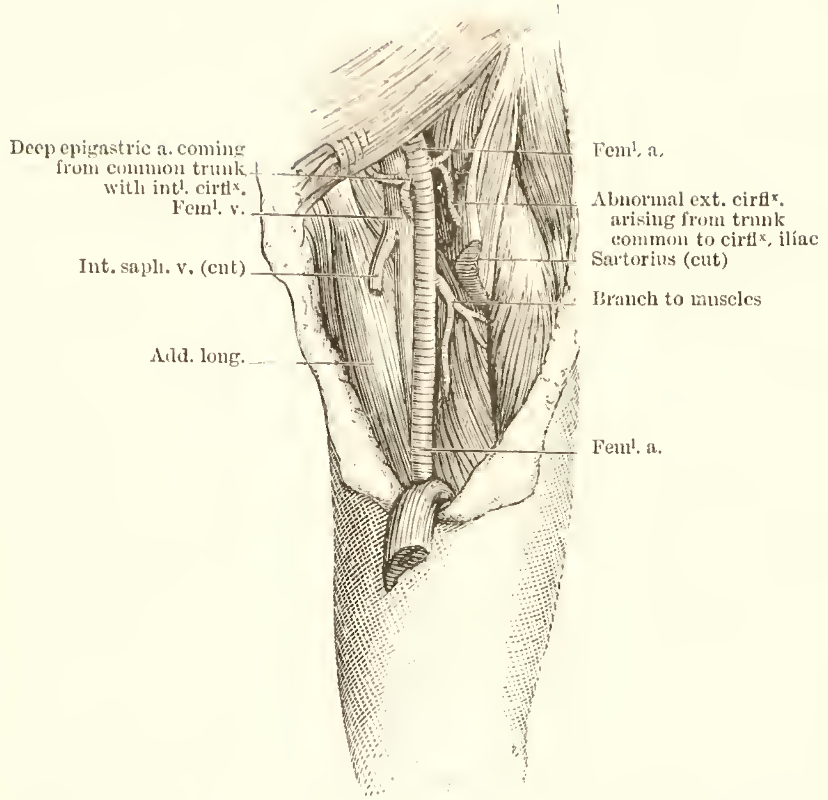


FIG. 557.—ANOMALOUS ORIGINS OF BOTH LEFT CIRCUMFLEX ARTERIES.

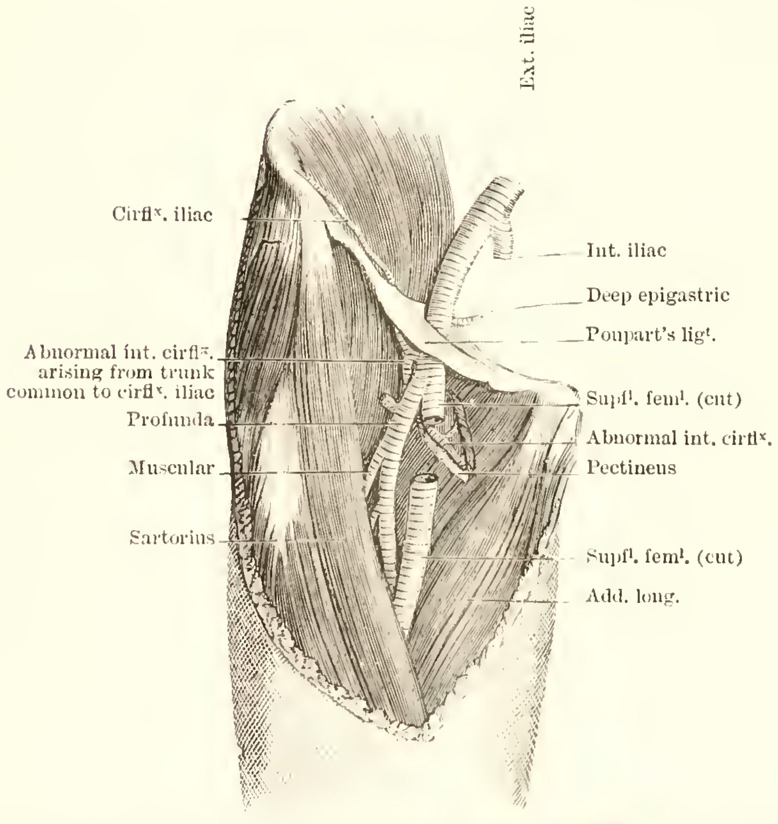


FIG. 558.—VARIATION IN ORIGIN OF RIGHT INTERNAL CIRCUMFLEX.

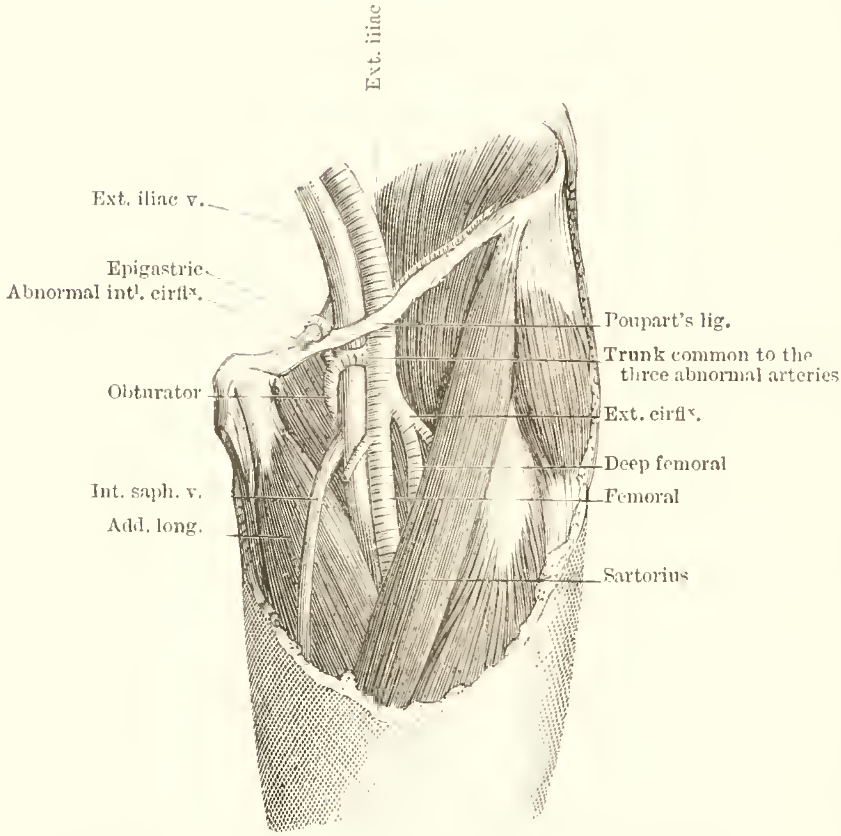


FIG. 559.—UNUSUAL ORIGIN OF INTERNAL CIRCUMFLEX.

VARIETIES OF THE FEMORAL VEIN.

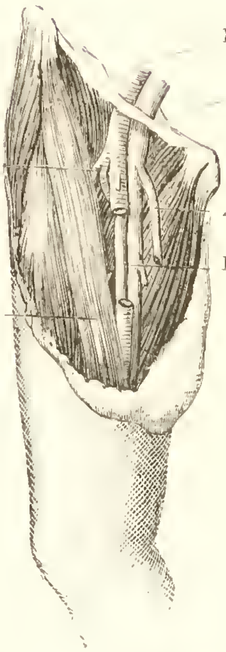


FIG. 560.—A DOUBLE FEMORAL VEIN.

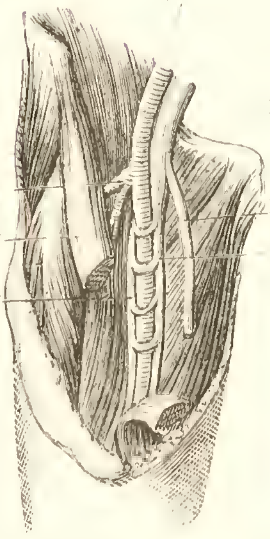


FIG. 561.—TWO ADDITIONAL VENÆ COMITES OF THE FEMORAL ARTERY WITH TRANSVERSE LOOPED ANASTOMOTIC BRANCHES.

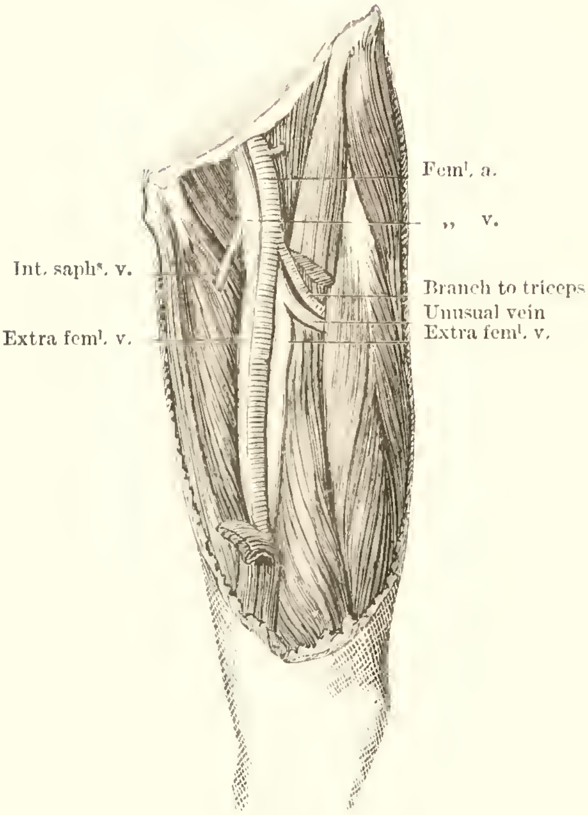


FIG. 562.—TWO LARGE FEMORAL VENÆ COMITES.

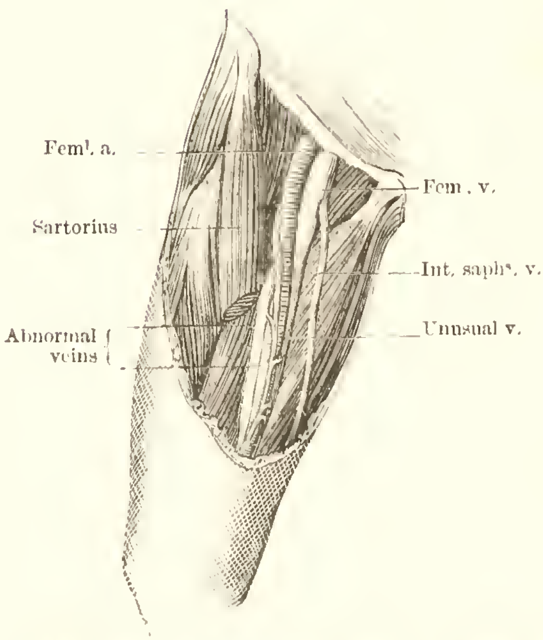


FIG. 563.—THREE UNUSUAL VEINS UNITING TO FORM THE FEMORAL.

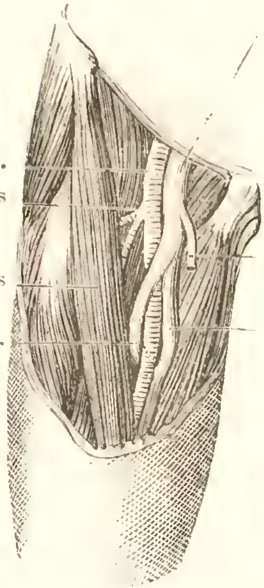


FIG. 564.—TWO UNUSUAL VEINS UNITING TO FORM THE FEMORAL.

HOW TO DISSECT THE BREAST.

The mamma may either be dissected *in situ* or after its removal from the body, and if the breast of a young married woman having borne children can be procured, or that of one having died in childbed or during lactation, its secreting structure being more fully developed will exhibit its composition better, and also be more easy to dissect. At the larger hospitals opportunities often occur in which the entire organ has to be removed for a comparatively small tumour, and as the parts are in a fresh condition they may be studied with advantage not only as to their coarser anatomy, but they will also permit of microscopic sections of the fresh tissue being made, stained, and mounted.

An incision should encircle the margin of the areola, and radiating cuts should be made from this to the base of the gland, and the skin reflected. The thinness of the skin near the areola and also any processes of the deep fascia passing through the front to the under surface of the cutis will be observed. If the gland have been removed from the body it should be fastened at its margins to the table by means of strong pins or slender nails, and the subcutaneous cellulo-fatty layer removed, care being taken as the neighbourhood of the areola is reached. Occasionally one or more small *subcutaneous bursæ* will be noticed, especially if the organ have been subjected to much pressure through the occupation or by badly fitting stays, and there is, not infrequently, a *submammary bursa*, which may be observed as the organ is being removed. The gland structure will be recognised by its rosy-white aspect (if fresh) and by its harder texture. Sometimes bristles may be passed along one or two of the larger nipple ducts, or they may even be injected by means of the apparatus described in the chapter on Anatomical Technics. This gland is more difficult to inject than any other organ in the body, and before attempting it the mamma should be well squeezed and manipulated, in order to press out any secretion or changed epithelium from the tubes. The lobules are more readily dissected under water on a black background. The student should then carefully remove the skin covering the areola and nipple, and proceed to identify the various structures described on the pages relating to the mamma, and afterwards a section should be made through the nipple, areola, and whole organ, so as to gain a better idea of the deeper arrangement of the lobes and lobules.

INDEX.

LONDON: PRINTED BY
SPOTTISWOODE AND CO., NEW-STREET SQUARE
AND PARLIAMENT STREET

BY THE SAME AUTHOR.

Will shortly be sent to press.

THE BREAST: its Cancers, Tumours, and other Diseases; their Causes, Pathology, and Treatment, with Original Researches on the Anatomy and Development of the Organ.

The MSS. of the following Works are nearly completed:

BODILY DEFORMITIES and their TREATMENT; a Handbook of Practical Orthopædics.

DISEASES of the RECTUM and ANUS; their Anatomy and Pathology, including the Modern Treatment of PILES, FISTULA, and STRICTURE.

PAPERS BY THE SAME AUTHOR.

On the Structure of Articular Cartilage (British Medical Journal, 1876).

The Treatment of Aneurism by Electrolysis (Leaders in British Medical Journal, 1874).

The Teaching of Anatomy (Leaders in British Medical Journal, 1875).

The Immediate Treatment of Piles (Lancet, 1877).

A Safe Method of Treating Rectal Fistulæ (Medical Times, 1879).

A Universal Scarpa's Shoe for the Treatment of all kinds of Club Foot (Medical Times, 1879).

An Urethro-cystoscope for the Examination and Treatment of Diseases of the Urethra and Bladder in Females (British Medical Journal, 1876), and Transactions of the Medical Society of London. Vol. 5. 1881.

The Treatment of Urethral Stricture, 1870.

Clinical Lectures on Practical Orthopædics (British Medical Journal, 1878).

Subcutaneous Extra-articular Osteotomy in Knock-knee and Bow-legs (Clinical Society's Transactions, 1879).

Practical Remarks on Lateral Lithotomy (Lancet, 1881).

The Treatment of Œsophageal Stricture, with special reference to Gastrostomy and Œsophagostomy (Clinical Society, 1881).

Colotomy and Excision of the Rectum in Malignant Rectal Obstruction (Harveian Society, 1880).

Dupuytren's Contraction of the Palmar Fascia (British Medical Journal, 1882).

Tumour Pathology (British Medical Journal, 1882).